Popular Astronomy.

Vol. XXXVI, No. 6 JUNE-JULY, 1928 Whole No. 356

THE NEW OBSERVATORY OF COLUMBIA UNIVERSITY.

By W. J. ECKERT.

The recent erection by Columbia University of an astronomical observatory on the top of a tall building in New York City was an experiment that has been watched with considerable interest. The observatory is built on the roof of the new thirteen-story Physics Building located at the corner of Broadway and 120th Street. Since the location of an observatory is usually chosen for the sake of a clear and steady atmosphere, the absence of artificial light in the neighborhood, and freedom from vibration, many have been curious to learn how these conditions could be met in the center of a great city. It seems desirable, therefore, to give a description of the new observatory, together with the reasons for choosing the location, and the methods by which some of the natural difficulties have been overcome.

The old observatory buildings of the university which consisted of a transit house and a small dome were built many years ago,[1] and in course of time not only became out of date, but their location was made undesirable by the growth of the city. The street lights on Broadway, being considerably higher than the observatory, were annoying when the telescope was pointed in their direction, and naked-eye observations made from the ground nearby suffered even more. The large classes in astronomy were handicapped by the lack of adequate lecture rooms and space for keeping clocks, sextants, etc. The greatest difficulty, however, arose from the recent increased building activity of the university. The construction of a ten-story chemistry laboratory a hundred feet to the south completely blocked the view in that direction, and the proposal of a thirteen-story physics building less than fifteen feet to the east made it apparent that the zenith and the north pole would soon be the only regions of the sky that could be observed at all. Professor Jacoby, of the Department of Astronomy, therefore urged the necessity of a new observatory that would be more favorably located and entirely modern.

Since the observatory was intended primarily for the instruction of students in the university it was very desirable to have it retained on the campus, and provision made for overcoming the difficulties of obtaining an unobstructed horizon and freedom from stray light and

[1] The transit house which was one of the first buildings to be erected on the present campus was built in 1896.

vibration. To prevent the view from again being blocked by the erection of new buildings, and also to get above as much of the glare of the lights of the city as possible, it was proposed to place it on top of a tall building. For this reason, and also because of the advantages to be gained from having it located near the department of physics with its excellent shop and laboratory equipment, it was decided to place it on the roof of the proposed physics laboratory. The plans of the building were somewhat revised and the observatory was made a part of the structure.

The new quarters of the department consist of about twenty-five hundred square feet on the roof, and a number of rooms on the upper floors. The large classes are held in the lecture rooms on the lower floors, and the astronomical library occupies a part of the physics reading room on the eighth floor. The building was so constructed that about one-third of the roof forms an open court, fifty feet on a side, surrounded by a stone parapet. Approximately one-fourth of this space is occupied by the housings of the permanently mounted instruments, while the remainder is left for the use of portable instruments and for naked-eye observations. The only communication between the roof and the floors below is by means of a flight of stairs and a bulkhead door which is kept closed to avoid air currents. This door opens upon the roof, and hence the observatory must be entered from the roof by means of a second door; thus making it impossible for warm air from below to rise past the instruments.

The two permanently mounted instruments are a 12⅜-inch equatorial telescope, and a 4-inch combined zenith telescope and transit instrument. The transit and zenith telescope is a Bamberg instrument, and is equipped with a self-recording eyepiece for transit observations. The equatorial was made by the firm of Alvan Clark,[2] and is modern in every respect, being equipped with an electrical driving clock, focusing ring for the attachment of instruments, Alemite lubrication, fine circles, etc.

The dome was especially built to withstand the strong winds at that altitude, and is electrically driven.[3] There is a movable floor which is raised and lowered by four large screws, and which is quite similar in construction to the rising stages used in many of the theaters.[4] Access to the floor is obtained by means of a folding staircase suggested by Professor Pegram of the Department of Physics. This staircase is hinged at the top, and the bottom slides in and out along a horizontal track when the floor is raised or lowered. Thus the individual steps

[2] Alvan Clark & Sons Company, 50 Henry Street, Cambridge, Mass.

[3] The dome was designed by Mr. R. W. Sellew, of Sellew and Towner, Central National Bank Building, Middletown, Conn.; and was built by The Berlin Construction Co. Inc., Berlin, Conn., and by the Farrell Foundry and Machine Co., Ansonia, Conn.

[4] The rising floor was made and installed by the Elevator Supplies Co., Inc., 1515 Willow Avenue, Hoboken, N. J.

always remain parallel and horizontal regardless of the inclination of the staircase as a whole; and access to the floor may be gained even while it is in motion. Since the observatory is intended primarily for the use of large classes, especial care was taken to have all machinery well guarded, so as to prevent accidents.

The small portable instruments, as well as the clocks, chronograph, and radio apparatus for receiving and recording the Arlington time signals, are kept in one of the rooms below. This room also contains a small switchboard, and has several electric lines running to the transit house and to the equatorial dome.

Some estimate of the degree of success in overcoming the natural limitations of light and vibration may perhaps be gathered from the following statements concerning the results that can be obtained. The height of the building has materially aided in eliminating the effects of the stray light of the city. On a clear night it is possible to see, with the naked eye, stars somewhat fainter than those of magnitude 4.5; but of course when the atmosphere contains much smoke or haze, more light from the city is reflected, and the limit of visibility is correspondingly higher. For telescopic observations the light is not so troublesome, for the dome shuts off most of the light from the observer's eyes. Stars fainter than the thirteenth magnitude can easily be seen; which is a little over a magnitude brighter than the theoretical limit of a telescope of that size.

The question of the vibration and swaying of the building caused considerable worry before the building was completed, but has really given little trouble. Except in very high winds, one would scarcely notice any unsteadiness, either with the transit instrument or with the telescope. These instruments are not mounted on piers reaching to the ground, but are supported by heavy steel girders embedded in concrete and extending from one side of the building to the other. It therefore seems that when the building sways in the wind, it moves in such a manner that the top, bottom, and sides always form a parallelogram. Thus any motion of the telescope owing to the swaying of the building will be a motion of pure translation without rotation; and since the celestial objects are at an infinite distance compared to the small possible displacement of the top of the building, the image cannot shift in the focal plane. In very strong winds there is some difficulty with the use of high power eyepieces; and at such times photography would probably be impracticable. While the telescope and transit instrument do not suffer much from vibration, some trouble is experienced in the use of artificial horizons for sextant work. The ordinary artificial horizon consisting of a dish of mercury is extremely sensitive to vibration and to winds which are usually quite strong on the top of a tall building. The difficulty has been overcome by substituting for the mercury a more viscous liquid such as glycerine. With such a liquid any small ripples due to disturbances of the container are quickly damped out, and a

good image of the sun is possible at any time. Another type of horizon consisting of a black glass mirror with leveling screws has also been found quite satisfactory.

The observatory has now been in use for nearly a year, and the results so far have been quite gratifying. As was mentioned above, the observatory reaps most of the benefits and few of the disadvantages resulting from its location in the city. The only effects of light and vibration which have so far been detected are not of such a character as to be noticed at all by elementary classes, and are not serious enough to make advanced work impracticable. The new observatory promises to be a very fine students' observatory, well fitted for the needs of the university.

COLUMBIA UNIVERSITY, NEW YORK CITY, MARCH 8, 1928.

EDWARD EMERSON BARNARD COMMEMORATION.*

Observing in the preliminary announcement of the program for the meeting of the A.A.A.S. at Nashville that Edward Emerson Barnard would be the subject of an illustrated lecture on Wednesday evening, December 28, by Dr. Robert G. Aitken, of the Lick Observatory, Mount Hamilton, California, the Executive Committee of the Tennessee Academy of Science decided to make Dr. Barnard the chief feature of its annual meeting which was to be held that week. This was deemed especially appropriate inasmuch as Barnard was born, reared, and educated in Nashville, here acquired the skill in photographic work so valuable to him later and made his first astronomical discoveries; also he had joined the Association just fifty years ago at its first Nashville meeting. The Committee planned also to have in connection with the meeting an exhibit consisting of books, pamphlets, photographs, and other objects relating to Barnard and that a special number of the *Journal of the Tennessee Academy of Science* be devoted to Barnard.

By correspondence with the Permanent Secretary of the A.A.A.S. and the Chairman of Section D (astronomy) arrangement was made for a joint session of the Academy and Section D and a program was devised in which each of the three periods of Barnard's life was represented by friends and associates of that period. The occasion was intended to be one for reminiscence. On the program the Nashville period was represented by J. M. Braid, P. R. Calvert, Olin H. Landreth, Mrs. Janie M. Baskervill; the Lick Observatory, by Robert G. Aitken; the Yerkes Observatory by D. W. Morehouse, Philip Fox, Samuel A.

*This account of the meeting in commemoration of the work of Edward Emerson Barnard held in Nashville, Tennessee, on December 28, 1927, was prepared for this journal at the request of the Editor by Dr. John T. McGill, Professor Emeritus of Organic Chemistry in Vanderbilt University, and Secretary-Treasurer of the Tennessee Academy of Science.

Mitchell, and Miss Mary R. Calvert.

The joint session was held in the Assembly Room of the Watkin's Institute in the afternoon of December 28, Dr. Robert G. Aitken, retiring Vice-president of Section D, presiding. The meeting was appropriately opened by Judge Robert Ewing, Chairman of the Board of Trustees of Watkin's Institute, a member of the reception committee at the meeting of the A.A.A.S. at Nashville fifty years ago and familiar with the early life of Barnard.

J. M. Braid, a chemist, photographer, and instrument maker, who came from Scotland to New York and from there in 1870 to Nashville, spoke of Barnard's first work with Van Stavoren, photographer and portrait painter, his enthusiasm for astronomy, his use of an old spy-glass as his first telescope, next a 2¼-inch lens and finally the 5-inch telescope with which he discovered his first comet in 1881 and the second in 1882.

Olin H. Landreth, a graduate of Union University and assistant in the Dudley Observatory at Albany came to Nashville in 1879 to take the position of Professor of Engineering in Vanderbilt University. He told of calling the attention of Bishop McTyeire and Chancellor Garland to Barnard and his admission, in disregard of requirements, as a special student and at the same time as assistant instructor in astronomy in charge of the observatory.

Dr. Aitken first described the social life at Mt. Hamilton in the early days when it was more isolated than now, the hospitality of Mr. and Mrs. Barnard in the little cottage on "The Flat" erected to shelter the workmen who built the observatory, Barnard's work with the 12-inch telescope, the 4-inch comet-seeker and, when it was ready, the "Crocker" telescope with its special photographic lenses. "Not until the summer of 1892 did Barnard have the use of the 36-inch telescope. With this he began immediately the study of the planet Jupiter, and on September 2, 1892, discovered the 5th satellite.

"This discovery, the most sensational one Barnard made, affords a capital illustration of his working methods and reveals his characteristics as an observer. It was no accidental discovery; he made his search with the definite object of determining whether or not a satellite existed nearer to Jupiter than the well-known Galileian satellites. A similar statement could hold true for nearly all his discoveries; almost every one resulted from a search definitely planned."

Professor Landreth, Mrs. Baskervill, and Dr. Mitchell were unavoidably absent from the meeting but Professor Landreth's paper was read and a paper afterwards received from Dr. Mitchell has been published in the *Journal of the Tennessee Academy of Science,* Vol. 3, No. 1.

Dr. Morehouse said, in part: "My contacts with Dr. Barnard extended through the years 1908 and 1909 at which time I was a student under him at the Yerkes Observatory. Long hours in the Observatory and

hours in the work room gave me an opportunity to know the heart and mind of Dr. Barnard. One cannot over emphasize his sincerity and fundamental honesty.

"For more than a year Professor Barnard, expecting the reappearance of Halley's comet, searched for it with his beloved 10-inch photographic telescope. One night Dr. Frost came to the door and called out 'Hoo-hoo, it is found.' Dr. Barnard asked for its position. He then picked up a photographic plate of two nights before, and by the aid of the comparator found he had the object on the plate, but not one word of complaint did he utter that would distract from the glory of Dr. Wolf's discovery. Dr. Barnard wanted his own, but he was equally insistent on giving everybody else due and just credit."

"My association with Professor Barnard," said Dr. Philip Fox, "dates from January, 1903, at which date I joined the staff of the Yerkes Observatory. For nearly seven years thereafter I occupied an office across the hall from him and in this contiguity and because of his hospitable, generous spirit, I came to know him intimately.

"Searching the heavens was the passion of his life consecrated to Urania, and never did man devote himself more completely to the service of his muse. He worked unflaggingly in dome, dark room, and office. With the great telescope he worked feverishly; with the Bruce photographic telescope he guided with the utmost patience; in his office his desk was always in distressing disorder, but it was the disorder accompanying construction, not neglect.

"There was something elemental in his make-up, in his simplicity, in his frank joy in poetry, trees, and song—an artist of the truest sort in his observing, full of naive enthusiasms. Yet there was something almost terrifying in the relentless pace he set in the pursuit of truth, the unsparing rod with which he drove himself. Here is a character about which legends will form and cling,—we see a rise from obscurity and poverty to the attainment of the most prized recognitions of greatness in this possessor of a most kindly, generous, and lovable personality.

"I have been thinking of something specific that might be done in the spirit of this commemorative meeting to perpetuate the memory of Barnard in the city of his birth. I am reminded that the old observatory of Berlin stood on Encke Platz; that in Paris I walked in streets about the Observatoire de Paris,—Rue Lalande, Boulevard Arago, Rue Herschel, Rue Cassini, and near l'Ecole Polytechnique in Rue Descartes, Rue LaPlace; and I have been wondering if in Nashville there is not an appropriately located street fine enough, beautiful enough to be called Barnard Boulevard."

It was appropriate that the session in honor of Mr. Barnard closed with a tribute by his niece, Miss Mary R. Calvert, who was his Secretary and assistant for many years at the Yerkes Observatory and after his death coöperated with Dr. Frost in completing his "Atlas of Selected Regions of the Milky Way."

"Mr. Barnard's most important work during the twenty-seven years he was at the Yerkes Observatory," she said, "was done with the 40-inch refracting telescope, chiefly of a nature very difficult with smaller instruments, such as observations of faint comets and variable stars and satellites of planets, the measurements of close double stars, and the relative positions of stars in some of the globular clusters.

"Observing was always a pleasure to Mr. Barnard, and he looked forward to each night with the telescope with an eagerness that seemed never to be dulled. This work came ahead of everything else and nothing was allowed to interfere with it. When his night at the telescope came he would have his early supper, be dressed for the night and at the observatory often before the sun was down. There was no last minute rush to the dome.

"With Mr. Barnard punctuality was a fixed habit. He was always ready for any engagement he might have on time or, more likely, a little ahead of time. Probably his long work at the telescope was partly responsible for this habit of extreme punctuality. One cannot be late in making an observation of an eclipse or any such celestial phenomenon.

"Another habit was painstaking to secure accuracy. How the prints were prepared and selected for his 'Atlas' is an illustration of this. He made positives from the original negatives and then second negatives from which the prints could be prepared. He selected fifty. From these a firm in Chicago made the 35,000 prints necessary for the 700 copies of the Atlas. Mr. Barnard personally inspected everyone of these, rejecting hundreds, and even thousands, which seemed to be lacking, in some detail, the excellence which he required."

The *Barnard Lecture* before the A.A.A.S. by the director of the Lick Observatory, the joint commemorative session of Section D (astronomy) of the A.A.A.S. and the Tennessee Academy of Science, the exhibit to which the four observatories in which he had worked all sent contributions awakened a greater interest in Barnard's career and a higher appreciation of his achievements by the people of his native city than they had ever before manifested. The January (1928) number of the *Journal of the Tennessee Academy of Science* is devoted to Barnard and serves, to some extent, to sustain this interest and appreciation. Several locations are to be marked by tablets, and, with the hope that the question of Dr. Philip Fox respecting a Barnard Boulevard may receive a favorable answer, it is proposed that the Mayor and City Council of Nashville be requested to give the name *Barnard* to the street which leads to the entrance of the Vanderbilt Campus near the observatory and the residence occupied by Mr. Barnard while he was connected with Vanderbilt University.

The *Barnard Exhibit* was located during the meeting of the A.A.A.S. on the mezzanine floor of the Hermitage Hotel. At the close of the meeting it was removed to the Carnegie Library where it remained for

six weeks. The transparencies of selected celestial photographs made by Barnard were presented by Dr. Edwin B. Frost, Director of the Yerkes Observatory, in behalf of University of Chicago to Vanderbilt University, and have been placed in the Vanderbilt Library.

The Exhibit included a life-size oil painting of Barnard by E. Calvert, photographs taken at various periods of his life (several also of Mrs. Barnard), photographs of his residences at Nashville, Mt. Hamilton, and Williams Bay, the Vanderbilt Observatory, and the Yerkes Observatory, the roof of the building where he was employed to turn the Van Stavoren camera and first made observations with his 5-inch telescope, the Van Stavoren Camera and the outdoor photographic wagon; the medals awarded him (loaned for this occasion by the Yerkes Observatory), and a collection of the writings of Barnard—books, pamphlets, and reprints of articles.

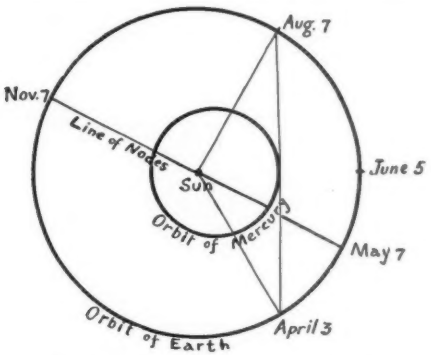
NASHVILLE, TENNESSEE, MARCH 21, 1928.

NAKED-EYE VISIBILITY OF MERCURY AND VENUS.

By R. J. A. BARNARD.

Observing from Melbourne (Lat. 37° 50′ S.) I found Mercury very brilliant in the spring of the last two years and easily visible to the naked eye for more than five weeks at a time. Consequently the statements made about the difficulty of seeing it seemed to me to be very much exaggerated. On looking into the matter, however, I find a remarkable difference between the conditions for the southern and the northern observer.

On account of the eccentricity of the orbit of Mercury, the greatest elongation varies very much at different appearances. It will be seen from the accompanying diagram of the orbits, that the greatest possible elongations are those which occur in the beginning of April and the beginning of August. (The dates on the diagram are approximate only.) The August ones are eastern (or evening) elongations, the April ones western or morning. At an eastern elongation in August Mercury is to the south of the sun, and therefore much better placed for observers in the southern hemisphere, and the same is also true of an eastern one in April. Consequently an observer in the northern hemisphere is at a permanent disadvantage as compared with one in the southern. The advantage of the southern observer is further increased by the fact that at the best evening appearances Mercury is considerably south of the ecliptic. To show the difference between the northern and the southern hemisphere, I give, in the following table, the dates of greatest elongation in 1926, and the difference in time of setting (or rising) of Mercury and the sun on that day for Melbourne, and for a place in the



ORBITS OF MERCURY AND EARTH, SEEN FROM SOUTHERN SIDE OF THE ECLIPTIC.

same latitude in the northern hemisphere. Doubtless the number of days of visibility varies in a similar way.

		Sets after or Rises before sun	
		Lat. 38° S	Lat. 38° N
		h m	h m
1926 Mar.	14 E. 18°	0 36	1 42
April	28 W. 27	2 18	0 58
July	10 E. 26	2 11	1 27
Aug.	25 W. 18	0 54	1 30
Nov.	5 E. 23	2 04	1 02
Dec.	14 W. 21	1 09	1 47

In Melbourne, on account of the weather, an elongation in September or October is better for observations than one in August even though the angle reached from the sun is not so large.

The facts connected with the two apparitions to which I have paid most attention are as follows:

	1926	1927
Superior conjunction	Sept. 19	Sept. 2
Greatest elongation	Nov. 5	Oct. 18
Stationary point	Nov. 15	Oct. 30
Inferior conjunction	Nov. 26	Nov. 10
Angular elongation	23°	25°

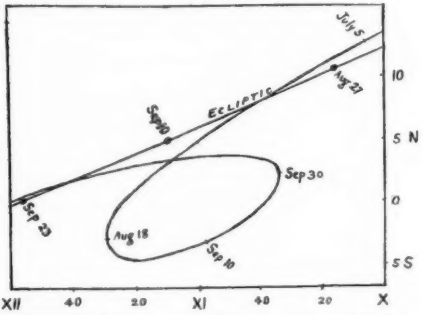
In 1926 I noticed Mercury first on October 12, and for the last time on November 15, when it was still 19° from the sun and of magnitude 0.5. I felt sure it might have been seen for a longer time and determined to watch carefully this year.

In 1927 I saw it first on September 17, when it set an hour after the sun, was about 12° from the sun and of magnitude —0.5. This was a satisfactory observation because on the fifteenth, though I located it with the field-glass, I was unable to see it with the naked eye. My last view of it was on October 26, when it was still quite bright. Unfortun-

ately I was disappointed in following it further by a week of unsettled weather, and I did not get a clear evening sky again until November 4 when I could not find it with the field-glass. It was then 11° from the sun and of magnitude about 1.5. On October 26, when I last saw it, it was of magnitude 0.4 and still set two hours after the sun, being 3° south of the ecliptic and 9½° south of the sun. It was evident that with fine weather I would have seen it for three or four days longer. As it was, from September 17 to October 26 there were 40 days of visibility to the naked eye.

Turning now to Venus, a very interesting feature this year was the position at the time of inferior conjunction. Superior conjunction had occurred on November 21, 1926, and I first saw it with the naked eye on December 25 when it set 35 minutes after the sun and was 9° from it.

Inferior conjunction in R.A. occurred on September 8, 1927, about 11^h Greenwich time, and conjunction in longitude about 16^h on Septem-



PATH OF VENUS IN THE HEAVENS IN 1927.

ber 10. The latter is the date given for conjunction in the *Nautical Almanac* and was the date on which Venus was nearest the sun. Conjunction took place therefore almost exactly midway between the nodes (about June 7 and December 7) and therefore Venus was about as far from the ecliptic at the time as it is possible for it to be. Its path on the celestial sphere consequently made a loop, which I have represented on the diagram. Venus was never nearer the sun than a distance of about 8° 40′. The result was an unusually favorable opportunity for southern observers to watch it right through the conjunction. A similar opportunity occurs for northern observers whenever conjunction takes place about March 7.

At Melbourne Venus rose before the sun and set after it for ten days in succession. I give a table showing the times of rising and setting compared with the sun on those days, and also rough distances on a few of them.

Date	Rises before sun	Sets after sun	Distance at Greenwich noon
Sept. 2	1^m	73^m	
3	5	66	
4	9	59	
5	14	51	
6	18	44	° ′
7	22	36	9 17
8	26	29	8 52
9	30	21	8 41
10	34	13	8 43
11	38	6	
12			9 26

I proposed making field-glass and naked-eye observations on its visibility during these days. Unfortunately cloudy weather intervened, so that I did not see it with the naked eye in the evening after the 7th, nor in the morning before the 12th. On September 7 it was sunset before I was able to pick it up with a common field-glass but 10 minutes later it was quite bright to the naked eye. The next two evenings were cloudy and I only glimpsed it with the field-glass for about half a minute on each evening about sunset. The following evenings were still more cloudy and I did not see it again in the evening. I looked for it first in the morning, on the 9th, but when I found it coming from behind a heavy bank of clouds, it was too late to see it except with the field-glass. The next two mornings were quite cloudy but the 12th was beautifully fine and Venus was brilliant when I first looked for it a few minutes after it rose. It remained visible to the naked eye until two or three minutes before sunrise.

As Melbourne time is 10 hours ahead of Greenwich, at the time of this last observation it was only 28 hours past conjunction. According to the *Nautical Almanac* not more than one-seventieth of the disc was illuminated at the time, and the greatest width of the crescent was less than a second.

The results suggest that under favorable conditions Venus is visible to within 9° of the sun both at superior and inferior conjunction, the magnitude in each case being about —3.4; also that in exceptional cases it is possible to follow Venus through inferior conjunction with the naked eye without missing a day.

Piscis Austrinus.

Into his bright mouth, Fomalhaut,
The Southern Fish receives a flow
Poured from the Water-Bearer's jar.
In finny guise, old myths declare,
Venus (poor fish!) is swimming there:
This tale is fetched almost too far.

1490 Stuart St., Denver, Colorado. LILIAN WHITE SPENCER.

THIRTY-NINTH MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY.

(Continued from page 304.)

ABSTRACTS OF PAPERS

ON THE DISTRIBUTION OF LIGHT IN THE SOLAR CORONA OF 1926.

By H. T. Stetson and L. B. Andrews.

Supplementary to the report on the photometric measurements of the total light of the corona for the 1926 eclipse at Sumatra, the present paper gives the results of an attempt to determine the law of variation in the brightness of the corona with increasing distance from the sun's limb and the sun's center. The plate was taken with a camera of 6-inch aperture and seventy-two inches focal length, of the Swarthmore Expedition, giving a scale of approximately thirty minutes of arc to the inch. The plate was carefully standardized before development on the evening following the eclipse by exposure to a Hefner lamp under standard conditions in connection with a Chapman-Jones plate tester.

About three hundred measures of opacity well distributed on the negative have been made with the thermoelectric photometer extending out to a distance of three and one-half solar radii.

In order to independently check the results of these selected measures a special form of rotating photometer was constructed to make possible the rotation of the plate during measurement, thus physically integrating the coronal brightness in concentric zones about the sun's center. On account of some dependence of galvanometer readings upon the angular speed of rotation, calibration plates were taken under standardizing conditions, the test plates being rotated during exposure to a known source. Measurements of these check plates on the rotating photometer gave corrections for any given speed of rotation which could be applied to the coronal measures similarly made. Measurements obtained with the rotating photometer agreed sensibly with those from the stationary photometer.

The mean result shows that for a distance of from one to two and one-half solar radii from the limb the brightness of the coronal light of 1926 varied inversely as $x^{2.8}$ where x is the distance of any point from the sun's limb in solar radii. Less exactly, the law of variation in recorded brightness may be expressed as an inverse function of $x_0^{4.4}$ where x_0 equals the radius of a given zone in the corona as measured from the sun's center and expressed in terms of the solar radius. An attempt is being made to extend this analysis of the integrated light so as to make possible a satisfactory interpretation of this law of apparent brightness in terms of coronal radiation three dimensionally considered.

A THEORY OF THE PRODUCTION OF DARK LINES IN STELLAR SPECTRA.

By John Q. Stewart.

Scattering. In previous papers (*Ap. J.*, LIX, 30, 1924; *Journal Opt. Society of America,* II, 581, 1925; etc.) the writer has put forward the theory that "absorption" lines in stellar spectra, and in the spectra of rarefied gases generally, are due primarily to scattering. This idea has lately been advanced again by Unsöld (*Zeitschrift für Physik,* **44**, 793, 1927). There is experimental evidence (*e.g.* A. S. Fairley, *Ap. J.*, LXVII, 114) that such scattering follows formulae developed from classical electron theory—the atom in this respect behaving analogously to a Hertzian oscillator of high frequency.

One way of looking at the matter is that the well-known Rayleigh formula for scattering holds fairly close to "resonance," where the opacity due to scattering is high inasmuch as the value of the refractive index departs considerably from unity (*cf.* photographs by A. S. King, *Mt. Wilson Contributions,* 131, 1917).

The width of a wide line thus produced varies theoretically as the product of the wave-length by the square root of the number of active atoms per unit column in the line of sight. This relation gives theoretical background to the empirical conclusion of Russell, Adams, and Miss Moore (39th Meeting, A.A.S.), that the Rowland intensities of Fraunhofer lines are related to the quantum probabilities.

True Absorption. Except at the edges of a line, however, scattering (diffusion in direction of the radiation) is not the only process involved. Even in an exceedingly rarefied gas true absorption, that is, the transformation of radiant energy in the gas, and emission—the transformation of thermal energy to radiant energy—also take place. A much more efficient process for such absorption and emission exists than mere Compton effect: namely, the work done by radiation pressure on the active atoms in consequence of their thermal agitation. If an atom, moving with speed u in the direction of propagation of non-isotropic radiation, is scattering energy E per unit time, the work absorbed from that radiation under radiation pressure, as kinetic energy of the moving molecule, is Eu/c, where c is the speed of light. If the atom is moving against the direction of propagation it will be slowed down, so that energy will be emitted.

Another mode of describing this process is that every time radiation is scattered from a moving atom it suffers a Doppler change in frequency which may be as great as $\pm\nu u/c$, where ν is the frequency of primary radiation. These Doppler shifts, furthermore, are cumulative, so that the probable net change increases indefinitely, as the square root of the number of successive scatterings.

The effect of this process of absorption and emission must be to

keep the center of an absorption line in a hot gas brighter than it would be under scattering alone, or than it would be if the gas were cool and the Doppler shifts small. Closer quantitative study of the effect obviously is required, in particular cases. The suggested process limits the application of the principle of "radiative equilibrium in each frequency separately," which has been uncritically employed in mathematical studies of the physical production of dark lines.

Observational data concerning contours of Fraunhofer lines in the sun are urgently needed. Such observations must be made with instruments of extreme resolving power—otherwise narrow lines will be measured as relatively too wide, and steep gradients will be filled in.

Stellar Spectra. Combining the theory of selective opacity here discussed with accepted ideas concerning general opacity of stellar photospheres, a rough formula for the width of lines in stellar spectra is obtained, which gives results of the right order of magnitude. If the abundance of active atoms is unchanged, the computed width is remarkably insensitive to temperature, varying about as $T^{3/8}$, while it also varies inversely as the fourth root of g, the surface acceleration of gravity. The latter result indicates that the amount of material above a photosphere varies inversely as $g^{1/2}$, being thus much greater in giants than in dwarfs.

Balmer Series. As the hydrogen lines become *narrower* in giants, their width would seem to be due to another cause than "imperfect tuning"—perhaps to a mutual molecular effect which is less in the rarefied giants. But the strength of the Balmer series in the cooler stars, in view of the high excitation potential involved, also indicates that for this element unusual widening occurs. If each excited hydrogen atom scatters according to the classical formulae, but with respect to a "natural frequency" displaced a suitable amount from the normal frequency, by, say, Stark effect, it is readily calculable that a minimum of, roughly, 10^{12} excited atoms per sq. cm. column would be required to make Hα an angstrom wide. The corresponding total number of non-ionized hydrogen atoms per unit column above the sun's photosphere would be, if the Boltzmann relation holds, of the order 10^{22}. The corresponding partial pressure at the photosphere is 4×10^{-4} atmosphere; and the sun's atmosphere might consist largely of hydrogen.

AN ATTEMPT TO OBSERVE THE SKJELLERUP COMET FROM AN AIRPLANE.

By James Stokley.

On December 17, 1927, a telegram was received by *Science Service* from the Lowell Observatory, stating that on the preceding day the Skjellerup Comet had been observed with the unaided eye in full daylight. As the morning progressed it became evident that a thin haze would prevent any observations at Washington. Through the courtesy

of the U. S. Air Service and the War Department, the use of an army airplane was obtained. At 1:30 P.M. the writer began a flight, with Lieut. F. O. Dice, U. S. A., as pilot. At 2:00 P.M. an altitude of 10,000 feet had been reached, sufficient to surmount the surface haze. It was seen, however, that a very thin cirrus haze, at perhaps 30,000 feet or higher, made so much glare near the sun as to prevent the object being seen. Had the comet been as bright as on the previous day, it is likely that it would have been seen, however. On account of the motion of the plane, it is unlikely that any photographs could have been made of the comet had it been visible.

THE OPTICAL PLANETARIUM.

By James Stokley.

By means of an instrument containing 117 separate projection systems, images of the naked-eye stars are projected on the inside of a white dome. The naked-eye planets are also represented, an appropriate mechanism for each reproducing their motions (geocentric) with great accuracy. An auxiliary projector permits the names of the constellations to be projected on the dome, while others project the coördinates; and an altitude scale along the meridian.

Motors controlled by the operator from the switchboard permit the heavens to be shown as seen from any part of the earth at any time of the year, while other motors move the instrument so as to show the effect of precession. Proper motions of stars are not represented. The annual motion of the planets among the stars can be run through in as little as seven seconds, thus showing in a striking manner the peculiarities of their orbits.

A popularly written account of the instrument by the writer will appear in an early issue of the *Publications of the Astronomical Society of the Pacific*.

A SPECTROSCOPIC INVESTIGATION OF BETA CEPHEI.

By Ralph N. Van Arnam.

The velocity variation of Beta Cephei, spectral class B1, has been studied by Frost, Crump, and Henroteau. Their work showed that the star, when interpreted as a spectroscopic binary, gave velocity curves characterized by variations in the values of the semi-amplitude and mass-center velocity. Photo-electric light curves obtained by Guthnick resulted in his classification of the star as a Cepheid variable. Further photometric study by Miss Cummings indicated peculiar behavior of the light curves.

The present study of the velocity variation is based on a series of plates obtained at the Dominion Astrophysical Observatory by S. L.

Boothroyd. The star was treated by the writer as a spectroscopic binary, for comparison with previous investigations.

The plates were nearly evenly divided into two groups taken at epochs three years apart. The orbital elements were derived from a mean curve representing all of the observations. A period of 0.1904841 days was used.

A least-squares solution yielded the results given in the last line of the table, which contains, also, the elements obtained by other observers.

COMPARISON OF ORBITAL ELEMENTS.

Observer, Frost (Prelim.); Date, July 6, 1906

γ	K	e	P	ω	T
— 4.9	16.9	0.03+	$0^d.190479$	165° 13′	J.D. 2,417,398.859

Observer, Crump; Date, August, 1912

γ	K	e	P	ω	T
—13.498	15.798	0.040	$0^d.1904795$	+2°.632	1912, Aug. 23.8119
± 0.21	±0.24	±0.015		±0°.917	

Observer, Crump; Date, Oct. 1, 1912

γ	K	e	P	ω	T
—11.857	19.222	0.052	$0^d.1904795$	+16°.526	1912, Aug. 23.8204
± 0.744	±0.741	±0.058		± 3°.438	

Observer, Van Arnam; Date, September, 1919

γ	K	e	P	ω	T
—9.79	11.34	0.052	$0^d.1904843$	58°.87	J.D. 2,422,219.820
±0.02	±0.04	±0.003	±0.00000004		

Crump $a \sin i = 40.541$ km
Van Arnam $a \sin i = 29,082$ km

The probable error of a single plate is ±2.12 km/sec.

The large fluctuations in the values of the semi-amplitude of the velocity curve and the center-of-mass velocity have been confirmed by all the investigators of its velocity curves. The variations in K and γ are somewhat masked when orbital elements are derived from a mean curve representing observations at different epochs. However, a preliminary discussion of the curves from the 1919 and 1922 observations, taken separately, served clearly to indicate these fluctuations. This preliminary least-squares solution, based on 32 plates obtained in 1919, and having an average probable error of ± 1.56 km/sec, gave these values for γ and K:

$$\gamma = -9.95 \pm 0.03 \text{ km/sec.}$$
$$K = 13.32 \pm 0.06 \text{ km/sec.}$$

The changes suggest the perturbing action of an invisible member. As yet the law of variation of γ and K has not been obtained.

The large differences between the values of ω, the longitude of the apse, are probably due to uncertainties connected with the small eccentricity. The writer adopted the procedure of including both ω and T in the least-squares solution.

The writer is indebted to Professor S. L. Boothroyd and Dr. J. S. Plaskett for suggestions offered.

A PHOTOGRAPHIC DETERMINATION OF THE DIAMETER OF MARS.

By P. van de Kamp.

The diameter of Mars has been measured on 123 photographs, distributed over 19 plates, taken through a yellow screen in the focus of the 26-inch McCormick refractor between July 20, 1924, and March 16, 1927. The apparent diameter varies from 25″ to 6″, which corresponds to 1.2 mm resp. 0.3 mm on the photographs. The dependence of the measured diameter on the photographic density can be expressed by a quadratic form:

$$\frac{d^2 d}{d D^2} = +0''.304 \pm 0''.017$$

corresponding to a range of 1″.2 in the measured diameters. The probable error of measurement of the diameter of an image of Mars amounts to 0″.06; the probable value of the error inherent in an image is 0″.11; the probable value of the plate error, common to the measured diameter of all images on the same plate amounts to 0″.18; the total probable error of the measured diameter of one image then amounts to 0″.22. The large variation in the apparent diameter makes it possible to eliminate any constant systematic error from the measured diameters. After reducing all measured diameters to the average squared density 3.2, a least squares solution gives 9″.48 ± ″.06 for the diameter of Mars at unit distance, and —0″.33 ± ″.11 for the constant term common to all measured diameters. This constant term, together with the dependence on photographic density, implies a range in systematic error of —0″.6 to +0″.6 for the measured diameters.

The effect of the incomplete representation of the geometrical image of the planet's disk for the majority of images, namely those with a density smaller than 2.3, probably is mainly due to the photographic action of developer and plate. The presence of systematic error in the photographic diameter of an image, due to photographic action, has also been found by Wright and Ross.

The value of the diameter found in the present investigation agrees satisfactorily with the value 9″.17 (12 images) and 9″.41 (14 images) found by Wright and Trumpler respectively from their photographs in yellow light, and with the mean result, 9″.31, from 6 visual determinations, in which the constant term has been eliminated.

NOTE ON THE DOUBLE STARS E 259 AND E 1031.

By Alexander Vyssotsky.

Both stars were observed with the micrometer at the McCormick Observatory and also measured on photographic plates. The comparison of these measurements with those by Espin shows a considerable difference for both stars, viz:

E 259

1905.93	p = 321°.9	d = 2″.80	Espin
1924.68	317.2	3.80	Vyssotsky, microm.
1924.67	318.7	3.68	.... photo.
1927.78	319.0	3.66	.... photo.

E 1031

1910.74	p = 251°.7	d = 2″.12	Espin
1924.79	350.3	1.72	Vyssotsky, microm.
1924.67	349.7	1.64	.... photo.
1927.71	350.6	1.30	.... photo.

Comparison of the plates of 1924 and 1927 gives the following proper motions with respect to eight comparison stars:

$$\text{E } 259 \qquad \mu_\alpha = +0^s.045, \quad \mu_\delta = -0''.006$$

$$\text{E } 1031 \qquad \mu_\alpha = +0^s.025, \quad \mu_\delta = -0''.004$$

with the average probable error, $\pm''.010$.

SOME RESULTS OF A PHOTOMETRIC STUDY OF THE DOUBLE CLUSTER IN PERSEUS.

By Alexander Vyssotsky.

The purpose of the present investigation is the measurement of the photovisual magnitudes and color indices of stars in the clusters h and χ Persei down to the 14th magnitude. The visual magnitudes published by Balanowsky (Pulkovo) and Vogt (Heidelberg) do not extend much below the 11th magnitude and at the present moment cannot be reduced to the International Scale of the North Polar Sequence. Each of two plates was exposed on the clusters as well as on the North Pole. The diameters of stars between magnitudes 10.0 and 13.0 were measured in two directions perpendicular to each other; the magnitudes were derived graphically, the reduction curve being based on the standard magnitudes of the North Polar Sequence. The limiting magnitude is very near to 14.0 visual. To study the structure of the clusters, all stars present on the plate were subdivided into four groups: (1) brighter than 11.0, (2) 11.00 - 11.99, (3) 12.00 - 12.99, (4) 13.00 - 14.0 magn. The numbers of stars of different groups were counted within rectangular areas extending 0°.06 in R.A. and 0°.6 in Decl., 16 such rectangles covering the whole plate. The number of stars between the clusters as well as those outside the clusters corresponds closely to the average number of stars for the same galactic latitude as given by van Rhijn.

Subtracting the number of these field stars from the numbers actually counted on the plate, we obtain the graphical representation of the structure of the clusters. The cluster h Persei appears to be rather regular with a well-defined center of concentration, while χ Persei is not so regular. The counts of stars inside of concentric circles of radii

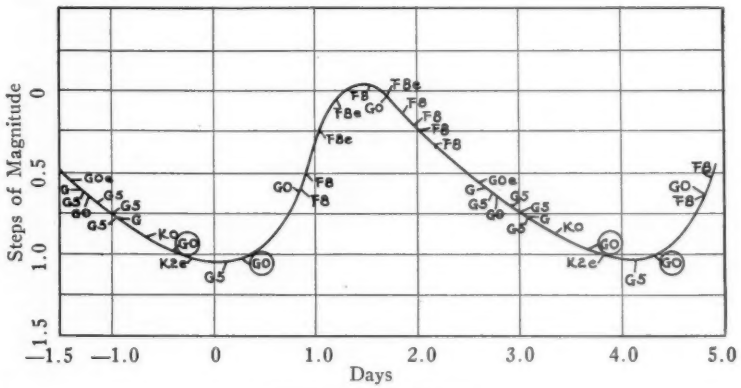
0°.03, 0°.06, and so on, give the density law, and the limiting radius for the stars of different magnitudes. We see that the cluster h Persei is well within the limits of the circle of diameter 0°.50 for the stars as faint as 14th visual magnitude. Similar results are obtained for the cluster χ Persei, although not so definite on account of the greater irregularity of the cluster.

The usual assumption, that the diameters of these clusters are as large as 1°, is thus not confirmed. The photograph of the portion of the Milky Way around the clusters published by the Lick Observatory suggests that the clusters are situated inside or even behind a large star cloud. If we extend the size of the clusters up to 1° we may as well include a much larger part of the cloud.

VARIATION IN SPECTRAL CLASS OF CEPHEID VARIABLES.

By Margaret L. Walton and Harlow Shapley.

A comparison of the Harvard and Mount Wilson work on the variations of the spectra of Cepheid variable stars was presented and some of the anomalies commented upon. In verification of Mount Wilson work, it is found that the spectra of Cluster-type Cepheids are not uniformly of Class A near the maxima. The variation in spectral class observed at Harvard appears to average twice as much as recorded by Mount Wilson observers.



BF Ophiuchi *(165926)*
Period 4.06790 days. Magnitude 7.2—8.0.

Detailed spectral variations of BF Ophiuchi (illustrated in the accompanying figure) and ER Carinae were discussed. Some of this material will be published soon at the Harvard Observatory; a part has already appeared in *Harvard Circular* 313.

PHOTOMETRY OF BALMER LINES IN A STARS.

By Emma T. R. Williams.

A preliminary study has been made of the intensity curves of the spectra of A stars. Eight typical stars of each of the spectral classes B8, A0, and A5 have been investigated. At least three plates have been secured of each star, each plate being standardized for photometric purposes by the laboratory method described by Dr. Dunham in *Harvard Bulletin* 853. It has been the object to adhere to standard conditions throughout as to telescope, dispersion, plates, microphotometer, etc.

From the material a mean value for "line depth" of each Balmer line from Hβ to Hρ, and of the [K] line, has been found for Class B8, for A0, and for A5. Thus the mean value for the line depth of Hδ in the B8 stars is 1.0 magnitudes; in the A0 stars, 1.35; in the A5 stars, 1.15. Mean values of differences in intensity between selected points in the continuous background have also been found. The residuals by which the results of a given plate differ from the mean results for the star, average 0.06 magnitudes for line depths and they also average 0.06 magnitudes for the continuous background measurements. Calculation of "total absorption" of the various lines is in progress.

It is hoped that this method will be valuable in reclassifying the brighter A stars. Thus, in the case of α Andromedae (A0p) the Henry Draper Catalogue remarks that it resembles Class A0 in respect to H and Ca+ lines while the He and C+ lines are of the same intensity as in Class B8. From spectrophotometric analysis of four plates of the star it appears that the line depths of the H lines and probably the total absorption too are about the same as in Class B8, and also the background measures place it rather earlier than A0.

A study along these lines is being undertaken which includes all A stars of northern declination brighter than magnitude 4.0 and all peculiar A stars of northern declination brighter than magnitude 5.0.

Lepus.

A rabbit, small and scared and fleet,
Is crouching at Orion's feet:
Behind, the Great Dog seems to spring.
Tho hare is quite a choice tidbit,
He never, never reaches it:
Which must be most discouraging.

1490 Stuart St., Denver, Colorado. Lilian White Spencer.

THE ORBIT OF URANUS.

By WILLIAM H. PICKERING.

The most productive orbit in the solar system today, by means of which one may search for unknown planets is undoubtedly that of Uranus. Its most conspicuous product is, of course, the planet Neptune, but it is believed that certain other at present unknown planets exist, whose influence on the orbits of the well-known brighter planets is distinctly marked and confusing. The orbit of Neptune, when fully known, will later form a still more sensitive field for research, but for the present little more can be done with it, now that it has already yielded its first marked perturbation caused by planet *O*. In my recent paper on that planet I showed in Figure 6, p. 152 of this publication, only that portion of the curve relating to Uranus which was of interest in connection with, and had a bearing on, the position of the companion of Neptune. In the present paper we shall examine the curve throughout its entire length, from the time that Uranus was discovered in 1781 until the latest published figures extending through 1925. About a dozen observations of Uranus, before it was recognized as a planet by Herschel, were made by different astronomers who supposed it to be an ordinary star. These measures, however, are too crude to be of any use to us in the present investigation. They will be found plotted in a series of curves in the *Harvard Annals*, **61**.

One of these curves, Figure 24, p. 142, was made the basis of the middle curve of Figure 6 above mentioned. While this curve, owing to the use of later observations, is an obvious improvement on that of Leverrier shown above it, our present knowledge of the probable existence and position of planet *P* renders a further improvement possible. The graphical method when used differentially as a correction gives extremely accurate results, probably more so than any other method, owing in part to the fact that it is possible to see exactly what effect is being produced by it. Instead of going back to the curve of Leverrier's orbit in this case, it will be more accurate to modify my own, which is already nearly correct. The sinusoid which was employed in that reduction had the following elements: Correction to the longitude for each revolution of the planet, to be subtracted,—3″.3, longitude and year of zero correction 250° in 1817, amplitude of the sinusoid 2″.0, and longitude of the ascending node 320°. On examining Figure 6 our attention is at once called to the long smooth wave-shaped deviation, extending through 180° of longitude between 40° and 220°. This is exactly the sort of curve that would be produced by an error in the assumed eccentricity, or in the longitude of the perihelion of the orbit.

We shall accordingly apply to it a sinusoid whose elements are as follows: Correction to the longitude for each revolution of the planet, to be subtracted, +2″, longitude and year of zero correction 175° in 1884, amplitude of the sinusoid 1″.0, and longitude of the ascending node 10°. In the present case it was seen to be best to make the last two corrections for the sinusoid first, since they were the more obvious.

TABLE I.

CORRECTIONS TO MY EARLIER ORBIT OF URANUS.

Date	H.L. °	Δ—C ″	Sin. ″	Period ″	True ″	Date	H.L. °	Δ—C ″	Sin. ″	Period ″	True ″
1781	90	—3.6	+1.0	—2.5	—2.1	1844	4	—0.1	—0.1	—1.0	+1.2
1782	93	—6.1	+1.0	—2.5	—4.6	1845	8	+0.2	0.0	—0.9	+1.1
1783	99	—5.0	+1.0	—2.4	—3.6	1846	12	—0.4	0.0	—0.9	+0.5
1784	101	—6.0	+1.0	—2.4	—4.6	1847	16	+0.3	+0.1	—0.9	+1.1
1785	105	—6.8	+1.0	—2.4	—5.4	1848	20	—1.4	+0.2	—0.9	—0.7
1786	109	—5.1	+1.0	—2.4	—3.7	1849	24	—0.1	+0.2	—0.8	+0.5
1787	114	—5.6	+1.0	—2.3	—4.3	1850	28	—0.6	+0.3	—0.8	—0.1
1790	129	—5.2	+0.9	—2.3	—3.8	1851	33	—1.7	+0.4	—0.8	—1.3
1791	134	—4.8	+0.8	—2.2	—3.4	1852	36	—1.7	+0.4	—0.8	—1.3
1792	139	—5.2	+0.8	—2.2	—3.8	1853	41	—1.9	+0.5	—0.7	—1.7
1793	144	—0.4	+0.7	—2.2	+1.1	1854	45	—0.1	+0.6	—0.7	0.0
1794	148	—0.7	+0.7	—2.2	+0.8	1855	49	+0.4	+0.6	—0.7	+0.5
1795	152	—1.5	+0.6	—2.1	0.0	1856	53	—0.2	+0.7	—0.7	—0.2
1796	158	—2.2	+0.5	—2.1	—0.6	1857	57	+0.6	+0.7	—0.7	+0.6
1797	162	—1.2	+0.5	—2.1	+0.4	1858	59	+0.7	+0.8	—0.6	+0.5
1798	166	—1.9	+0.4	—2.0	—0.3	1859	62	—0.1	+0.8	—0.6	—0.3
1800	175	+0.2	+0.3	—2.0	+1.9	1860	70	—0.2	+0.9	—0.6	—0.5
1801	181	+1.0	+0.2	—2.0	+2.8	1861	74	+0.9	+0.9	—0.6	+0.6
1802	184	+1.3	+0.1	—2.0	+3.2	1862	78	+0.7	+0.9	—0.5	+0.3
1805	199	+2.8	—0.2	—1.9	+4.9	1865	90	—0.2	+1.0	—0.5	—0.7
1806	204	+2.5	—0.2	—1.8	+4.5	1866	96	+0.8	+1.0	—0.4	+0.2
1807	208	+2.6	—0.3	—1.8	+4.7	1867	101	+1.2	+1.0	—0.4	+0.6
1808	213	+4.3	—0.4	—1.8	+6.5	1869	105	+1.0	+1.0	—0.4	+0.4
1810	222	+4.0	—0.5	—1.7	+6.2	1870	110	+0.1	+1.0	—0.4	—0.5
1812	231	+3.5	—0.6	—1.7	+5.8	1871	116	+0.5	+1.0	—0.3	—0.2
1813	235	0.0	—0.7	—1.7	+2.4	1872	119	+0.3	+0.9	—0.3	—0.3
1814	241	+3.1	—0.8	—1.6	+5.5	1873	124	+0.8	+0.9	—0.3	+0.2
1815	244	+3.6	—0.8	—1.6	+6.0	1882	167	+0.2	+0.4	0.0	—0.2
1817	254	+0.7	—0.9	—1.6	+3.2	1883	172	+0.7	+0.3	0.0	+0.4
1818	258	—0.5	—0.9	—1.5	+1.9	1884	177	+0.8	+0.2	0.0	+0.6
1819	263	—0.5	—1.0	—1.5	+2.0	1885	181	0.0	+0.2	0.0	—0.2
1820	267	—2.0	—1.0	—1.5	+0.5	1886	186	+0.1	+0.1	+0.1	—0.1
1822	276	+2.2	—1.0	—1.4	+4.6	1887	191	+0.2	0.0	+0.1	+0.1
1823	280	—0.6	—1.0	—1.4	+1.8	1888	196	+0.3	—0.1	+0.1	+0.3
1824	284	+0.9	—1.0	—1.4	+3.3	1889	200	—0.2	—0.2	+0.1	—0.1
1825	288	—1.8	—1.0	—1.4	+0.6	1890	205	—0.2	—0.3	+0.2	—0.1
1826	292	+1.4	—1.0	—1.4	+3.8	1891	209	—0.3	—0.3	+0.2	—0.2
1827	296	0.0	—1.0	—1.3	+2.3	1892	214	0.0	—0.4	+0.2	+0.2
1828	300	+3.6	—0.9	—1.3	+5.8	1893	218	—0.9	—0.5	+0.2	—0.6
1829	305	—2.3	—0.9	—1.3	—0.1	1894	223	—0.8	—0.5	+0.3	—0.6
1830	309	—2.5	—0.9	—1.3	—0.3	1895	227	—0.7	—0.6	+0.3	—0.4
1836	333	—0.9	—0.6	—1.1	+0.8	1896	232	—0.4	—0.7	+0.3	0.0
1837	337	—0.6	—0.5	—1.1	+1.0	1897	237	+0.1	—0.7	+0.4	+0.4
1838	341	+0.8	—0.5	—1.1	+2.4	1898	241	+0.7	—0.8	+0.4	+1.1
1839	345	+0.1	—0.4	—1.0	+1.5	1899	246	+0.3	—0.8	+0.4	+0.7
1840	349	+0.3	—0.4	—1.0	+1.7	1900	250	+0.9	—0.9	+0.4	+1.4
1841	353	+1.2	—0.3	—1.0	+2.5	1901	255	+1.3	—0.9	+0.4	+1.8
1842	357	+0.4	—0.2	—1.0	+1.6	1902	259	+1.4	—0.9	+0.5	+1.8
1843	0	+0.7	—0.2	—1.0	+1.9	1903	264	+1.8	—1.0	+0.5	+2.3

In Table I the first three columns are taken from the first, second, and fifth columns of Table XXVI, p. 137, of the *Annals* above mentioned, the last named column giving the measured deviations of Uranus from my earlier orbit. The fourth column gives the corrections for the sinusoid, and the fifth the corrections for the inclined line which corrects the period. The sum of these two corrections subtracted from the figures in the third column gives what I believe to be the true measured deviations of Uranus from its orbit in each of the various years, as deduced from the observations made from 1781 to 1903 inclusive.

When an old theory of a planet's orbit is abandoned, and a new one adopted, no recognition is given to the older one, and the differences in the published results at the date of change are sometimes marked. Thus, according to Greenwich, the observed deviation of Uranus from its true position in 1903 as deduced from Leverrier's orbit was —3″.1. When Newcomb's orbit was adopted in 1904, Greenwich gave the deviation of Uranus from its true position as +1″.97,—a change of over 5″ in the course of a single year! Such a change it would appear would play havoc with the work of the planet hunters. It is the business of the planet hunter then to overcome such a difficulty as best he can. Gaillot and the writer each did his best in his own way, and their modifications of Leverrier's orbit are shown in the second and third curves of Figure 6. My modification at that time gave the deviation for Uranus in 1903 as +1″.8, or only 0″.2 less than the Greenwich result in 1904. My present modification makes the deviation in 1903, +2″.3, or 0″.3 greater.

TABLE II.

DEVIATIONS FROM NEWCOMB'S ORBIT OF URANUS.

Date	H.L.	Green.	Wash.	Mean	Dev.	Date	H.L.	Green.	Wash.	Mean	Dev.
	°	″	″	″	″		°	″	″	″	″
1904.5	268	+1.97	+0.97	+1.47	±0.50	1915.6	314	+1.78	+2.09	+1.94	±0.16
1905.5	273	+1.09	+1.52	+1.30	±0.22	1916.7	318	+2.25	+2.10	+2.18	±0.08
1906.6	277	+1.77	+0.83	+1.30	±0.47	1917.7	322	+1.52	...	+1.52	...
1907.5	281	+2.04	...	+2.04	...	1918.7	326	+1.54	...	+1.54	...
1908.5	285	+1.14	+1.81	+1.48	±0.34	1919.7	330	+2.02	+2.33	+2.18	±0.16
1909.5	289	+1.69	+1.95	+1.82	±0.13	1920.7	334	+1.89	+2.20	+2.04	±0.16
1910.5	294	+2.66	+2.68	+2.67	±0.01	1921.7	338	+2.06	+2.07	+2.06	±0.01
1911.6	298	+2.61	...	+2.61	...	1922.7	342	+1.93	+2.41	+2.17	±0.24
1912.6	302	+1.73	+1.88	+1.80	±0.08	1923.7	346	+0.96	+2.57	+1.76	±0.80
1913.6	306	+3.14	...	+3.14	...	1924.7	351	+1.62	+2.77	+2.20	±0.58
1914.6	310	+2.34	+2.78	+2.56	±0.22	1925.8	354	—2.12	...	—2.12	...

Greenwich's latest change is from —0ˢ.10 in 1924 to +0ˢ.13 in 1905. Reversing the signs, so that the deviation shall indicate O—C instead of C—O, we find that this means a sudden drop of 3″.7 in one year. The probable reason for this correction will appear presently. In Table II are given the deviations of Uranus from Newcomb's theory from 1904 to 1925 inclusive, according to Greenwich and Washington. The table is arranged like those previously published. The next to last column gives the true measured deviations of Uranus according to Newcomb's orbit for the various years. No modifications of the theory

appear to be necessary, except to increase all the longitudes by $0^s.1$ or $1''.5$. This is most readily done by a shift in the origin of the ordinates in the accompanying curve, Figure 1, which illustrates both tables.

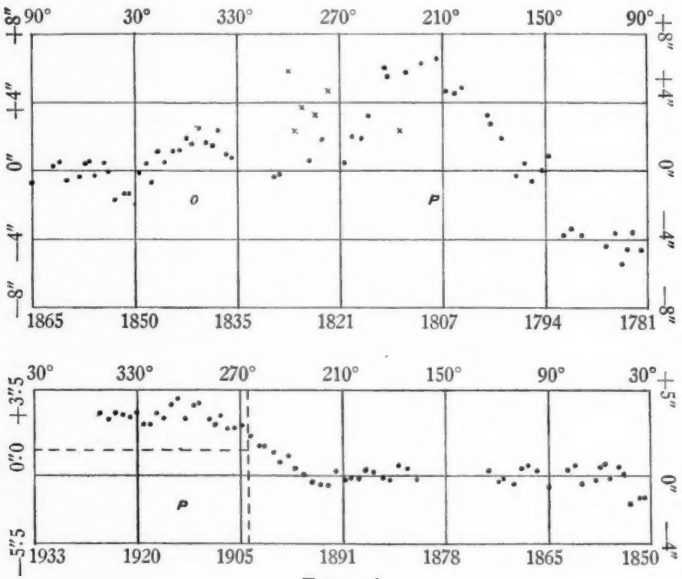


FIGURE 1.
PERTURBATIONS OF URANUS.

As in our previous curves the abscissas represent heliocentric longitudes increasing towards the left, and are taken from the second columns of the two tables. The ordinates are taken from the last column of Table I and the next to last of Table II, a positive ordinate indicating that Uranus has been pulled forward ahead of its normal position, and a negative one that it is being held back. The first thing perhaps that strikes our attention is that by the lower curve between longitudes 45° and 237°, or between 1854 and 1897, that is for half a revolution, Uranus proceeded on its way undisturbed by any other attraction than that of the Sun. Both before and since that quiet period its course has been very irregular. The break in this portion of the curve caused by lack of available observations will be explained presently. In 1904 when Newcomb's theory of Uranus was to be adopted, he probably and naturally tried to start the planet off in accordance with its more recently observed positions, perhaps going back to longitude 240°.

This view I have indicated, as above stated, by assuming his origin of ordinates to be $1''.5$ above mine, and marked it in the figure by the horizontal dotted line. This position also falls in best with the devia-

tions, which continue to increase by a uniform annual amount, instead of dropping sharply on and after the year that the new orbit came into use. Unfortunately, however, the planet would not stay where Newcomb's orbit had placed it, but kept continually getting farther and farther ahead, until longitude 306°, where according to Greenwich it was 3″.4 ahead of the theory. Indeed, as we see by the next to last column of the table, the planet never has agreed with the theory within less than 1″.3. It is a rather curious circumstance that Greenwich should have diminished the deviation in 1925 by 3″.74, as shown by the third column, for this brings the planet back to, and a little below, my origin of ordinates as shown by the fifth. Nevertheless I believe that Greenwich made a mistake, and that in the course of a dozen years or so the planet will have worked back of itself to Newcomb's orbit, and that in a dozen years more the deviation will be reversed, leaving the planet perhaps on my orbit, and behind its computed place according to Newcomb.

It appears to me that the location of the planet between longitudes 45° and 237°, 1854 to 1897, in the lower curve gives us the true origin of ordinates. In no other portion of its orbit, ancient or modern, can we modify it by a sinusoid whose period is 360°, so as to give a uniform result of such long duration. In the upper curve these same longitudes, as far as they are plotted, present a very different appearance, so it is clear that conditions there have changed since then. The average correction given by the last column of Table I between these dates is +0″.02, with an average deviation of ±0″.34, or ±0^{s}.02, which gives us some idea of the accuracy of even these earlier observations. The maximum correction recorded is only 0″.7, so that it is clear that at the present time any deviation from the zero ordinate of the curve amounting to as much as 1″.0 really means something, and requires explanation.

With regard to the missing observations in the lower curve between longitudes 124° and 167°, there should be seven of them in all, one year being missed, since the maximum shifted from a December to a January observation. All the observations through the year 1873 are taken from the *Memoirs of the Paris Observatory*, 1873, **14**, Part I, A 86. Beginning with 1882 and through 1903 the *British Nautical Almanac* employed these same elements, and the deviations from them are found in the *Greenwich Observations* for successive years. For the intermediate dates 1874 to 1881, reference may be made to the *Annals of the Paris Observatory*, **28**, as mentioned in the *Memoirs of the Lowell Observatory*, I. These last results I have never seen.

In neither of the perturbation curves of Uranus by Neptune, or of Neptune by *O*, Figures 3 and 5 of my earlier paper, pages 147 and 151, did either of these planets fall much below the heavy horizontal lines of their undisturbed orbits prior to their marked perturbations. The same is true of all the perturbations shown in Figure 1 of the present paper, with the one marked exception of the upper curve prior to longi-

tude 140°. If the great deviation of nearly 90″ in the orbit of Uranus, due to Neptune, shows no marked preceding minimum, it does not seem probable that this comparatively small perturbation should show such a marked effect. This appears also to have been the opinion of Gaillot, who doubtless had access to Leverrier's original papers. It is believed, therefore, that the marked break in the curve at this point is due to a change of ordinates made by Leverrier himself or by other early computers, and probably rightly, and furthermore that the prominent perturbation, which appears to have its maximum near longitude 213°, should be measured from the zero ordinate only. After the great perturbation of Uranus by Neptune, Figure 3, progress is shown towards a marked minimum. This feature does not appear in any of the other perturbations, unless possibly we find it following that marked *O* in Figure 1 above.

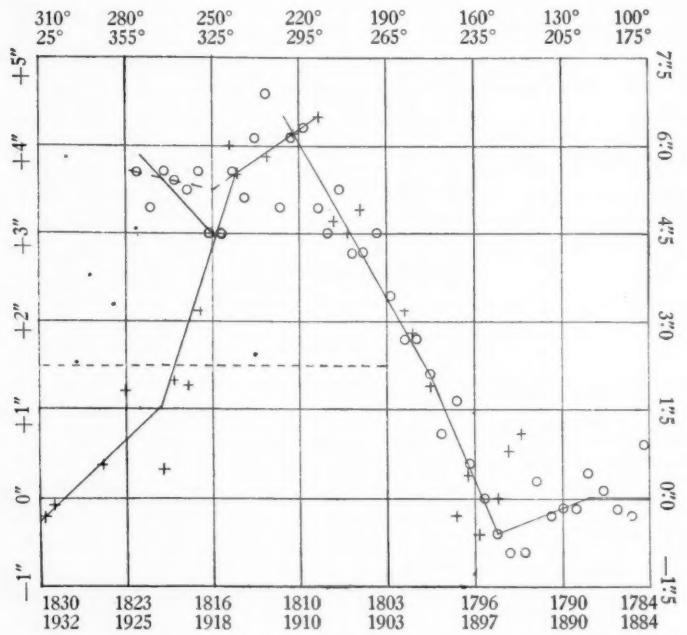


FIGURE 2.
SUPERIMPOSED PERTURBATIONS OF URANUS.

Two other perturbations in Figure 1 are also shown. While *O* has already been accounted for by the planet of that provisional name, the question may now naturally be asked can the other two be properly attributed to a single body, namely planet *P*? The date of the maximum of the earlier perturbation appears to be 1810. The date of the later

1911.6, giving thus an interval of 101.6 years. The resulting period of the unknown planet, if its orbit were circular and in the ecliptic, would then be 485 years, and its distance from the Sun 61.7 units. These results are entirely possible, and we believe therefore that a single unknown planet is sufficient to account for both of these perturbations.

In order to make a more satisfactory comparison of these two curves, they have been superposed in Figure 2, the abscissas and dates for the earlier curve being placed above those of the later one. The ordinates for the first curve are placed at the right of the figure. All of those for the second are taken from my origin. We must therefore add 1".5 to the figures given in the fifth column of Table II. They are on a scale 1.5 times as great as those of the first curve. The planet is obviously massive, and since it proves to be more remote from the Sun than the distance separating the components of many visual binaries with which we are acquainted, and since their orbits are all distinctly eccentric, we should rather expect its orbit also to show considerable eccentricity. Since the ordinates of the first perturbation are 1.5 times as great as those of the second, this is quite what we might expect to find, and implies that at the second conjunction with Uranus, P was $\sqrt{1.5}$ or 1.22 times as remote from that planet as it was at the first one. We shall presently see, however, that another explanation, involving the six latest deviations, is also possible. The earlier deviations are indicated by crosses, the later ones by circles. A broken line has been drawn through them in order to indicate how the two sets of abscissas should be superimposed. The best results it was found were obtained when the difference of longitude was 75°. The first series begins at longitude 144°, earlier observations, which would lie below the figure, having been rejected as previously explained. From then until longitude 250°, the observations of the two perturbations coincide as well as might be expected, each set agreeing with the broken line sufficiently well to justify the selection of the difference of longitude above mentioned. Beyond 250° they part company, the earlier observations giving what we may call the standard perturbation curve as indicated also in Figures 3 and 5 of "The Next Planet Beyond Neptune," pages 147 and 151 of this publication. All three of these curves, measured horizontally from the point where they first became steep at the bottom, have a width ranging from 155° to 180° of longitude, they are all pointed at the top, and are all steeper on the following than on the preceding side, as they should be according to our earlier paper, p. 147. Six observations of the earlier perturbation in Figure 2 differ by more than 2" from the broken line, and are scattering with regard to one another, and the observations about them. They have therefore been rejected, and are indicated by dots.

Returning to Figure 1, during the 144 years covered by the curve, Uranus has completed one and three-quarter revolutions in its orbit. This interval is sufficient for it to have passed every unknown planet

whose distance from the Sun exceeds 35 units, at least once. In my last paper on "The Orbits of the Comets of Short Period" it was shown that there was reason to believe in an unknown planet *S* of considerable mass, whose mean distance from the Sun is about 48 units, and whose period therefore is 333 years. Two perturbations of this distant planet, if it exists, may be found on the curve. Returning to Figure 2, if this belief is true, it is easy to see that if a maximum perturbation by *S* occurred in 1924, the six latest observations of Uranus, which are certainly correct, are fully explained. This is satisfactory enough, but if the orbit of *S* is circular, then its overtake period by Uranus is 112 years. If its orbit is elliptical the period may be a few years longer or shorter. Where then is the earlier perturbation which we have not noticed? Clearly it falls in 1812, longitude of Uranus 231°. But this most unfortunately is very near the maximum due to *P*, which as we can see by Figure 2 falls at 222°. Planet *S* will not greatly hinder our location of *P*, but it certainly does render very uncertain any determination of the eccentricity of its orbit, and to that extent is clearly a nuisance. Fortunately the last maximum of planet *P* is still so recent, and its orbital motion so slow, that if it is found in the next few years, posterity will not have to wait another hundred for the next perturbation.

Another point must now be noted. Since it is clear from Figure 1 that there are no more large perturbations in the orbit of Uranus, it is certainly highly improbable that any other large unknown planet, besides those already described, can exist beyond Neptune, unless it is located very far from the plane of the ecliptic, or in what we may describe as almost interstellar space. For all purposes therefore we may say that there are still three large unknown planets in our system, and further, with these two possible exceptions, there are certainly no more.

It will now be evident that, while the analytical method adopted by Leverrier and Adams was well adapted to discover Neptune, which gave a single large perturbation of 90″, it would be quite hopeless to attempt to use it in such a complicated case as is produced by these three unknown planets, all causing small perturbations of about the same size.

In my next paper I hope to locate planet *P*, and give some idea of its mass and brightness. I may say now, however, that its longitude appears to be 294°, and the longitude of *S* about 344°, but I do not think it is worth while to look for either of them until my next paper is published.

PRIVATE OBSERVATORY, MANDEVILLE, JAMAICA, B. W. I., APRIL 25, 1928.

NOTE ON COMETARY APHELIA.

In my recent paper* entitled "The Orbits of the Comets of Short Period," in connection with the formula for *L*, it should have been

*See POPULAR ASTRONOMY for May, 1928. p. 274 ff.

stated that the final term $\pm 180°$ is used only in case ω is less than 180°. It is necessary to be very careful in the use of this formula, not only regarding the signs of the angles, but also in the selection between the two values of L'. If a comet were to move in the plane of the ecliptic, we should then have the simple formula

$$L = \omega + \Omega \pm 180°.$$

Even if the inclination of the orbit is considerable, this formula gives an approximately correct result, and this serves as a useful check on the computation. We sometimes see it stated that if the elements of a comet closely resemble those of a previous one, they are likely to be identical, or at least to belong to the same family group. While this is true, it is also the case that the same comet may sometimes return with an utterly changed set of elements. Thus three of the elements of comet Brooks, number 492, 1911 I, were

$$\omega\ 343°.5,\ \Omega\ 18°.2, \text{ and } i\ 6°.1.$$

When it returned in 1925 as number 562, after an encounter with Jupiter, these elements had changed to

$$\omega\ 195°.7,\ \Omega\ 177°.4, \text{ and } i\ 5°.6.$$

By the change of the node the inclination of the orbit had shifted through 11°, and the other elements were wholly different. An application of the formulas for the latitude and longitude of the aphelion, however, shows that in spite of the changed elements, the longitude had shifted through only 11°, and the latitude through 0°.2. W.H.P.

OCCULTATION OF SIGMA SAGITTARII, JULY 2, 1928.

By WM. CLETUS DOYLE.

Two unfortunate circumstances will render the observation of this occultation somewhat difficult and unspectacular. First, the immersion, which will be visible only in the Eastern States, will occur while the moon is rather low in the sky. Secondly, since the moon is full at 8:48 P.M. (Central Standard Time), the little second magnitude star will be rather inconspicuous. But it might be well here to remind the non-professional astronomer who has not a large telescope at his disposal that occultations of second magnitude stars do not happen so frequently that he can afford to let one slip by. If he were to look up POPULAR ASTRONOMY for January, 1927, and May, 1928, he would find there some articles by Professor E. W. Brown of Yale Observatory urging amateur astronomers to make more frequent observations of occultations and to publish the results.

It is for this purpose that the accompanying charts are published,

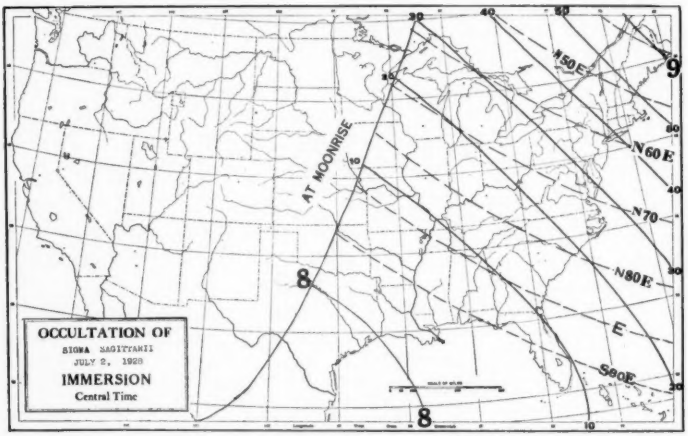


FIGURE 1.

namely, to let them know the circumstances and time, within a few minutes, of occultations of stars as bright as the third magnitude. We would appreciate some comment from those interested and also a record of observations. If sufficient interest is shown, charts for even fainter stars will be published.

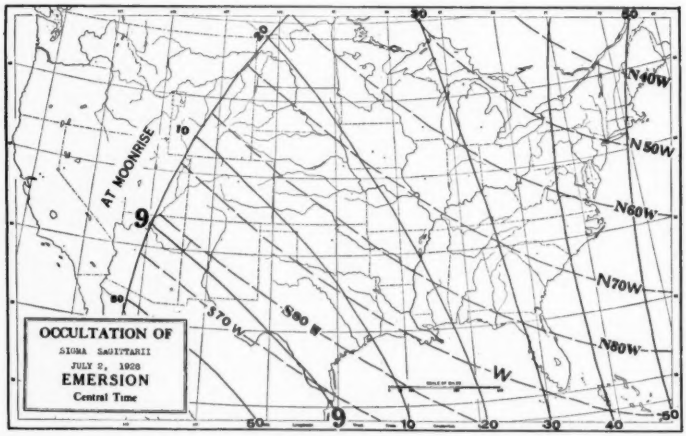


FIGURE 2.

On the charts the full-lined curves give the time of immersion (Figure 1) and emersion (Figure 2) for the places over which they pass. They are drawn for ten-minute intervals, the large numbers representing the full hour of Central Standard Time. Note that the time of im-

mersion varies from 8:00 P.M. in Texas to 9:00 P.M. in Maine; the emersion between 8:50 in Mexico to 9:50 in the extreme eastern section of the country. The broken lines represent the angular distance from the North or South Point on the Moon at which the star will enter. For the immersion this varies from 50 degrees East of North (N50E) to 80 degrees East of South (S80E); for the emersion from 40 degrees West of North (N40W) to 70 degrees West of South (S70W).

Though this graphical method does not give the exact minute of occurrence, many observers who do not wish to compute the time will find it a great time saver.

CREIGHTON UNIVERSITY OBSERVATORY, OMAHA, NEBRASKA.

A CONTINUING UNIVERSE.

By JERMAIN G. PORTER.

We do not have to go very far back in the history of cosmology to find the belief general that the world was created some six thousand years ago. Modern astronomy having shown this idea to be untenable, the beginning has been pushed farther and farther back, millions or even billions of years; but always there is the thought of some remote epoch when out of nothing the heavens and the earth were brought forth. They may have existed originally as chaotic fire-mist, to evolve gradually into the present wondrous universe, but in the beginning there must have been an act of creation.

Such, I take it, is the view held not only by theologians, but probably also by the majority of scientific men, including astronomers. When we look into the future the theologians seem to have the best of it, for they promise, in some unknown clime, an eternity of bliss; while the poor astronomer is driven to the gloomy outlook of a universe growing old, and sinking finally into the coldness of utter death. In other words, the process of evolution has been thought of as tending ever in one direction, involving the gradual dissipation of energy through radiation.

This view, however, has always seemed to me to ignore the fact that we find in the heavens stars in every stage of development, from the uncondensed nebulae, through the giant stars of low temperature, the white, the yellow and red stars, even to those which have already lost their light and reveal their presence only by the attractive force they exert on their neighbors. We can avoid this difficulty, of course, by supposing that creation took place at successive periods, a hypothesis which will hardly appeal to the scientific mind. The only other view that will account for the varied types among the heavenly bodies is that in some way they are rejuvenated, that after becoming cold and dead they are changed again into the nebulous form to begin once more the process of evolution.

I have in past years suggested to my classes the possibility that when a star sinks to the absolute zero of temperature the molecular forces cease to act, and the body dissolves into a dark nebula; that this dark nebula, slowly absorbing the heat from surrounding stars, becomes finally a bright nebula, and thus begins its new course of evolution. This naturally was a mere hint of a possible explanation of a process that I conceive must be taking place. Two articles recently published perhaps throw greater light on the subject. The first is an account of investigations by R. R. Kleeman quoted in the *Literary Digest* of January 20, 1928. He finds that the instability of certain substances at the absolute zero of temperature may lead to explosions; and he remarks that "this result has an interesting astronomical aspect. Dark bodies in interstellar space which are losing more heat than they receive eventually sink in temperature to near the absolute zero, and then may possibly get unstable and explode. This may conceivably happen some day to our moon if it radiates more heat than it receives and has compounds in its composition possessing this property." A body exploding in this manner may well be converted into a dark nebula.

The second article is also quoted in the *Literary Digest,* March 17, from *Daily Science News Bulletin.* It gives an account of Nova Pictoris which burst out in 1925. "The evolution of stars," Dr. Shapley, Director of Harvard College Observatory, remarks, "is generally thought to be in the direction from nebula to star; but in this instance, and in two or three others, the transformation is in the opposite direction." And further on, "These suddenly expansive transformations are the reverse of the normal course of stellar evolution, * * * and may be exceedingly important in our knowledge of the development of celestial bodies."

There is yet another recently discovered phenomenon which may have a bearing on this subject, and that is the so-called hard rays that Millikan has detected, and whose origin seems to be somewhere out in the depths of space. An attempt has been made to connect this radiation with the long period variables of the Mira Ceti type; but may it not well be a manifestation of the highest form of energy surging throughout all space, the integrated energy perhaps of all the mighty stellar systems? This energy would certainly be absorbed to some extent by the dark nebulae, which might thus begin anew their evolutionary course.

Since it is impossible to imagine any boundaries to space, the universe must be infinite in extent. That it is likewise without beginning or end in duration, ever rising like the fabled phoenix out of its own ashes, would seem to be a necessary corollary, now beginning to be visioned by astronomy for the first time. Concerning the Spirit which motivates this framework of nature, science may well agree with the Psalmist, "From everlasting to everlasting Thou art God."

CINCINNATI OBSERVATORY, APRIL 5, 1928.

PLANET NOTES FOR JULY AND AUGUST.

By CLIFFORD E. SMITH.

The *Sun* during this period will be moving southeast from the central part of Gemini, across Cancer, and on to the central part of the constellation Leo. On July 4, the sun will be farthest from the earth. The positions of the sun on July 1 August 1, and August 31, will be respectively: R.A. $6^h\,39^m$, Decl. $+23°\,9'$; R.A. $8^h\,44^m$, Decl. $+18°\,9'$; and R.A. $10^h\,36^m$, Decl. $+8°\,49'$.

The phases of the *Moon* will occur as follows:

Full Moon	July	2 at	9 P.M.	C.S.T.
Last Quarter		10 "	6 A.M.	"
New Moon		16 "	11 P.M.	"
First Quarter		24 "	9 A.M.	"
Full Moon	Aug.	1 at	10 A.M.	C.S.T.
Last Quarter		8 "	11 A.M.	"
New Moon		15 "	8 A.M.	"
First Quarter		23 "	2 A.M.	"
Full Moon		30 "	9 A.M.	"

The moon will be at perigee (nearest the earth) on July 14 and August 10, and at apogee (farthest from the earth) on July 26 and August 23.

Mercury will be in the western part of Gemini early in July. During this period it will cross Cancer and on into Leo. The first part of July its apparent motion will be retrograde. Thereafter during July and August its motion will be eastward. On July 21 Mercury will be at greatest elongation west and at that time it will rise about an hour and a quarter before the sun. On August 16 Mercury will be at superior conjunction, and on August 18 it will be in conjunction with Neptune.

Venus will be in Gemini at the beginning of this period, and during July and August it will move to the eastern border of Leo. On July 1 Venus will be at superior conjunction and on August 10 it will be in conjunction with Neptune. Late in August Venus will set about an hour after the sun.

Mars during July will be in Aries and during August it will move to the central part of Taurus. On July 3 Mars will be in conjunction with Jupiter. At this time these planets will be rather close to each other in the sky, being separated by an angular distance equal to about half the diameter of the moon. Late in August Mars will be about seven degrees north of Aldebaran and will be about an hour east of the meridian at sunrise.

Jupiter will be in Aries. On August 1, Jupiter will be in quadrature west of the sun. Thus during the middle of this period Jupiter will rise about midnight.

Saturn will be in Ophiuchus some ten degrees northeast of Antares. In September Saturn will be in quadrature east of the sun so that at the end of this period it will be near the meridian at sunset.

Uranus will be in Pisces. During the first part of August Uranus will be about two hours west of the meridian at sunrise.

Neptune will be in Leo. Its apparent position during this period will be near that of the sun, and consequently not well situated for observation. On August 10 it will be in conjunction with Venus, on August 18 it will be in conjunction with Mercury, and on August 22 it will be in conjunction with the sun.

Occultations Visible at Washington.

[From the *American Ephemeris.*]

Date 1928		Star's Name	Magnitude	IMMERSION. Washington C.T. h m	IMMERSION. Angle from N °	EMERSION. Washington C.T. h m	EMERSION. Angle from N °	Duration h m
July	2	σ Sagittarii	2.1	21 19	68	22 33	305	1 14
	6	143 B. Capricorni	6.1	0 9	27	1 8	294	1 0
	6	154 B. Capricorni	6.1	6 0	28	6 57	275	0 57
	9	26 Ceti	6.0	23 28	42	0 19	266	0 51
	10	33 Ceti	6.1	3 27	18	4 26	271	0 59
	19	46 Leonis	5.8	19 30	54	19 56	0	0 26
Aug.	1	33 Capricorni	5.3	22 22	6	22 54	320	0 32
	2	37 Capricorni	5.7	4 46	104	5 33	203	0 47
	4	30 Piscium	4.7	23 15	84	0 20	214	1 5
	11	121 Tauri	5.1	2 3	92	2 55	236	0 52
	12	ϵ Geminorum	3.2	4 18	122	5 4	219	0 46
	13	κ Geminorum	3.6	3 24	98	4 16	259	0 52
	22	41 Librae	5.3	18 52	71	19 58	333	1 7
	22	κ Librae	5.0	21 3	99	22 18	291	1 14
	30	161 B. Capricorni	6.4	0 34	45	1 48	253	1 14
	30	69 Aquarii	5.6	19 29	76	20 37	240	1 7
	30	τ Aquarii	4.4	21 1	15	21 50	293	0 48

Asteroids Discovered. — In the year from July 1, 1926, to June 30, 1927, 112 asteroids were announced. Two of these were later found to be the same one, seven were identified with asteroids previously known, and one was found to be a nebula. There were, therefore, only 103 new ones. Orbits for 16 of these have been computed at the Astronomisches Rechen-Institut in Berlin, and published in *A.N.* No. 5559, thus bringing the number of minor planets to 1072.

Modern Eclipse Problems, by F. J. M. Stratton. (Oxford University Press, 1927.)

This pamphlet contains the text of the *Halley Lecture,* delivered on May 20, 1927. The author begins with a reference to Halley's record of a failure to observe a total eclipse of the sun in England in 1724, and ends with suggestions relating to the observing of the eclipse on June 29, 1927. Between these two items the author presents an account of the advancement of astronomical science as it relates to solar eclipses, for the purpose of showing what remains to be done. The pamphlet has, perhaps, greater interest for the professional than for the amateur astronomer. There are a few good photographs of the corona and of spectra.

VARIABLE STARS.

Variable Star Predictions. — For many years the approximate times of maximum light for a list of short period variables and the times of minimum light for another list of short period variables have been published a month in advance in Popular Astronomy. As the computation involved requires considerable time, and since space in the magazine is greatly in demand at present, we are desirous of finding out to what extent these predictions are used. If they are needed we shall gladly continue them. If they do not serve any useful purpose, we shall replace them with more important material. We should appreciate a line on this question from any of our readers who are concerned with these pages.

Minima of Variable Stars of Short Period.

[Calculated by members of the classes in Astronomy at Carleton College.]

Given to the nearest hour in Greenwich civil time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of Minima in 1928							
					July				August			
	h m	° ′		d h	d h		d h		d h		d h	
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8	1 9				5 7			
RT Sculptor.	31.5	—26 13	9.6—10.5	0 12.3	4 8		18 16		9 4		23 12	
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	5 20		20 19		4 19		19 18	
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	8 5		20 11		7 19		26 3	
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	8 1		25 4		11 7		22 17	
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	9 16		23 10		6 3		19 21	
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	7 20		26 23		10 7		24 15	
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	9 11		25 8		10 5		26 3	
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6	0 21				2 4			
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	8 0		25 5		11 9		28 14	
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	8 9		20 7		7 3		24 23	
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	8 15		24 10		9 6		23 1	
RW Tauri	3 57.8	+27 51	7.1— [11	2 18.5	2 18		19 9		5 1		21 15	
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	2 16		20 10		7 5		24 23	
RW Persei	13.3	+42 04	8.8—11.0	13 04.8	2 4		28 13		10 18		23 23	
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	8 1		20 15		8 12		21 2	
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	9 19		22 5		3 15		28 12	
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	8 14		25 4		10 18		21 20	
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	6 11		22 19		8 4		24 12	
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	9 22		21 23		9 0		21 1	
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	7 22		20 22		9 10		22 10	
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	7 20		23 11		8 1		23 16	
SV Gemin.	54.6	+24 28	9.8— [11	4 00.2	5 4		21 5		6 5		22 6	
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	7 10		24 14		5 1		22 6	
U Columbæ	6 11.2	—33 03	9.2—10.0	2 19.2	11 6		23 17		11 10		23 21	
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	3 17		24 5		6 21		20 13	
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	9 1		24 7		8 13		23 19	
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	2 0		26 10		7 15		21 20	
RU Monoc.	6 49.4	— 7 28	9.8—10.5	0 21.5	5 1		19 9		9 22		24 6	
R Can. Maj.	7 14.9	—16 12	5.8— 6.4	1 03.3	9 20		23 11		6 2		19 18	
RY Gemin.	21.7	+15 52	8.9— [10	9 07.2	9 23		28 13		6 20		25 11	
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	5 13		18 19		7 15		20 20	
TX Gemin.	30.3	+17 08	10.0—11.9	2 19.2	4 6		21 1		6 20		23 16	
RR Puppis	43.5	—41 08	9.4—10.7	6 10.3	10 17		23 13		11 20		24 17	
V Puppis	7 55.4	—48 58	4.1— 4.8	1 10.9	7 19		22 8		5 21		20 10	
X Carinæ	8 29.1	—58 53	7.9— 8.7	0 13.0	9 4		23 6		6 7		20 9	
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	5 10		24 9		2 20		21 20	
RX Hydræ	9 00.8	— 7 52	9.1—10.5	2 06.8	4 19		23 1		10 7		28 13	
S Velorum	29.4	—44 46	7.8— 9.3	5 22.4	7 2		24 21		5 18		23 13	
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	6 23		20 11		9 17		23 4	
RR Velorum	10 17.8	—41 36	10.0—10.9	1 20.5	3 15		18 11		9 17		24 13	
SS Carinæ	54.2	—61 23	12.2—12.8	3 07.2	11 15		24 20		13 15		26 20	
RW Urs. Maj.	10 35.4	+52 34	10.3—11.4	7 07.9	8 17		23 9		7 1		21 17	
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	8 20		22 10		5 0		18 14	
RZ Centauri	12 55.6	—64 05	8.5— 8.9	1 21.0	5 20		20 21		11 9		27 9	
RS Can. Ven.	13 06.3	+36 28	7.5—12.5	4 19.1	8 16		23 2		6 11		20 20	
SS Centauri	07 2	—63 37	8.8—10.4	2 11.5	5 7		20 4		4 1		18 22	
SX Hydræ	13 39.0	—26 23	8.6—12.7	2 21.5	10 17		22 7		2 21		20 6	
δ Libræ	14 55.6	— 8 07	4.8— 6.2	2 07.9	8 5		22 4		5 3		19 3	
U Coronæ	15 14.1	+32 01	7.6— 8.7	3 10.9	6 5		20 1		9 18		23 13	
TW Draconis	32.4	+64 14	7.3— 8.9	2 19.4	4 5		21 1		6 21		23 18	
SS Libræ	15 43.4	—15 14	9.3—11.5	0 18.4	6 6		20 15		4 0		18 9	

Minima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of Minima in 1928							
					July				August			
	h m	° ′		d h	d h		d h		d h		d h	
SW Ophiuchi	16 11.1	— 6 44	9.2—10.0	2 10.7	10 3		24 19		8 12		23 4	
SX Ophiuchi	12.6	— 6 25	10.5—11.2	2 01.5	11 19		24 4		11 18		24 4	
R Aræ	31.1	—56 48	6.8— 7.9	4 10.2	5 15		23 8		10 1		25 17	
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	10 16		31 10				21 4	
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	10 10		24 0		6 15		20 6	
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	1 16.2	6 9		19 19		8 22		23 8	
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	10 8		22 16		10 3		21 10	
TX Herculis	15.4	+42 00	8.3— 9.0	2 01.4	9 17		22 2		9 15		22 0	
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	11 13		26 17		10 1		24 19	
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	9 11		19 7		7 22		22 15	
TX Scorpii	48.6	—34 13	7.5— 8.2	0 22.6	10 3		23 7		12 2		25 7	
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	3 4		24 20		4 17		26 9	
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	4 14		20 13		5 13		21 12	
WX Sagittarii	53.6	—17 24	9.2—10.8	2 03.1	10 22		23 16		11 20		24 15	
WY Sagittarii	17 54.9	—23 01	9.5—10.6	4 16.0	9 5		23 5		10 21		24 22	
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	7 0		22 12		7 1		22 12	
RS Sagittarii	11.0	—34 08	5.9— 6.3	2 10.0	7 6		21 18		12 12		27 0	
V Serpentis	11.1	—15 34	9.5—11.1	3 10.9	5 14		19 9		9 3		21 22	
RZ Scuti	21.1	— 9 15	7.4— 8.3	15 03.2	15 19		30 23		13 4		30 9	
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	3 5		18 15		3 1		18 11	
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	5 6		23 1		9 19		27 14	
SX Sagittarii	39.7	—30 36	8.7— 9.8	2 01.8	10 14		27 5		12 20		29 11	
RR Draconis	40.8	+62 34	9.3—13	2 19.9	7 13		24 13		10 12		27 12	
RS Scuti	43.7	—10 21	9.3—10.3	0 15.9	10 1		26 0		10 22		26 21	
β Lyræ	46.4	+33 15	3.4— 4.1	12 21.8	11 17		24 15		6 13		19 11	
U Scuti	18 48.9	—12 44	9.1— 9.6	0 22.9	9 7		24 14		8 21		24 3	
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	14 22		30 1		14 5		29 8	
RV Lyræ	12.5	+32 15	11. —12.8	3 14.4	5 15		20 1		3 10		17 20	
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	1 14		19 12		6 9		24 7	
U Sagittæ	14.4	+19 26	6.5— 9.0	3 09.1	9 3		22 15		5 4		18 16	
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	4 1		22 19		9 21		24 15	
TT Lyræ	24.3	+41 30	9.4—11.6	5 05.8	5 14		21 7		6 1		21 18	
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	5 19		22 2		7 10		23 17	
SY Cygni	19 42.7	+32 28	10. —12	6 00.2	9 6		21 6		8 6		20 7	
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	7 7		27 5		6 3		26 1	
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	5 1		23 9		10 16		28 23	
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	8 23		25 20		11 17		28 13	
RW Capric.	12.2	—17 59	8.8—10.6	3 09.4	10 10		24 1		13 10		26 23	
UW Cygni	19.6	+42 55	10.5—13	3 10.8	4 16		18 12		8 5		22 1	
V Vulpec.	32.3	+26 15	8.2— 9.8	37 19.0								
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	3 6		22 12		1 2		20 7	
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	9 9		23 4		10 14		19 18	
Y Cygni	48.1	+34 17	7.1— 7.9	2 23.9	11 6		23 6		4 6		22 5	
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	11 0		25 6		8 13		22 19	
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	6 11		21 15		10 20		20 22	
RY Aquarii	21 14.8	—11 14	8.8—10.4	1 23.2	8 4		25 20		6 16		18 11	
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3			21 1				21 8	
RT Lacertæ	21 57.4	+43 24	9.1—10.5	5 01.7	7 7		22 12		6 17		21 23	
RW Lacertæ	22 40.6	+49 08	10.2—11.2	5 04.4	6 19		22 6		6 19		22 8	
VW Pegasi	22 51.7	+32 42	10.0—10.6	5 06.4	8 19		24 16		9 13		25 9	
Y Piscium	23 29.3	+ 7 22	9.0—12.0	3 18.4	11 11		26 12		10 14		25 15	
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	7 22		20 7		5 19		22 7	

Maxima of Variable Stars of Short Period.

[Calculated by members of the classes in Astronomy at Carleton College.]

Given to the nearest hour in Greenwich civil time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900		Decl. 1900		Magnitude	Approx. Period		Greenwich civil times of Maxima in 1928							
								July				August			
	h	m	°	′		d	h	d	h	d	h	d	h	d	h
SX Cassiop.	0	05.5	+54	20	8.6— 9.2	36	13.7			15	14			21	3
SY Cassiop.	0	09.8	+57	52	9.3— 9.9	4	01.7	7	7	23	14	8	20	21	1
RR Ceti	1	27.0	+ 0	50	8.3— 9.0	0	13.3	11	12	22	14	8	4	24	18
RW Cassiop.	1	30.7	+57	15	8.9—11.0	14	19.2	11	19	26	14	10	10	25	5
V Arietis	2	09.6	+11	46	8.3— 9.0	0	23.8	12	7	26	4	9	2	22	23
SU Cassiop.	2	43.0	+68	28	6.5— 7.0	1	22.8	11	14	27	5	11	19	27	9
RW Camelop.	3	46.2	+58	21	8.2— 9.4	16	00.0	7	15	24	1	9	10	25	20
SX Persei	4	10.2	+41	27	10.4—11.2	4	07.0	11	9	24	6	10	10	23	6
SV Persei		42.8	+42	07	8.8— 9.6	11	03.1	4	2	26	8	6	11	28	17
RX Aurigæ	4	54.5	+39	49	7.2— 8.1	11	15.0	3	8	26	14	7	5	30	11
SX Aurigæ	5	04.6	+42	02	8.0— 8.7	1	12.8	8	11	20	17	8	2	20	9
SY Aurigæ		05.5	+42	41	8.4— 9.5	10	03.3	8	21	29	4	8	7	28	14
Y Aurigæ		21.5	+42	21	8.6— 9.6	3	20.6	8	9	23	20	8	6	23	17
RZ Gemin.	5	56.6	+22	15	9.1—10.0	5	12.7	7	17	24	7	9	21	20	23
RS Orionis	6	16.5	+14	44	8.2— 8.9	7	13.6	3	15	18	18	10	11	25	14
T Monoc.		19.8	+ 7	08	5.7— 6.8	27	00.3	3	11	30	11			26	11
RT Aurigæ		23.0	+30	33	5.1— 6.0	3	17.5	7	23	22	21	6	18	21	16
W Gemin.		29.2	+15	24	6.7— 7.5	7	22.0	4	9	20	5	5	1	20	21
ξ Gemin.	6	58.2	+20	43	3.7— 4.3	10	03.7	5	11	25	18	4	22	25	5
RU Camelop.	7	10.9	+69	51	8.5— 9.8	22	06.5	12	8			3	11	25	14
RR Gemin.	7	15.2	+31	04	10.0—11.5	0	09.5	6	5	22	2	7	0	22	21
V Carinæ	8	26.7	—59	47	7.4— 8.1	6	16.7	10	4	23	13	12	15	26	1
T Velorum	8	34.4	—47	01	7.6— 8.5	4	15.3	5	15	24	5	7	3	21	1
V Velorum	9	19.2	—55	32	7.5— 8.2	4	08.9	10	0	23	3	9	14	22	17
Z Leonis	9	46.4	+27	22	7.9— 9.6	56	08.7	7	19						
RR Leonis	10	02.1	+24	29	9.1—10.1	0	10.9	6	19	20	9	7	12	21	1
SU Draconis	11	32.2	+67	53	8.9— 9.6	0	15.8	9	20	23	1	11	20	25	1
S Muscæ	12	07.4	—69	36	6.4— 7.3	9	15.8	2	6	21	14	9	22	29	5
SW Draconis		12.8	+70	04	8.8— 9.6	0	13.7	7	16	24	18	5	3	22	5
T Crucis		15.9	—61	44	6.8— 7.6	6	17.6	8	19	22	6	11	11	24	22
R Crucis		18.1	—61	04	6.8— 7.9	5	19.8	8	22	20	13	7	1	18	16
S Crucis	12	48.4	—57	53	6.5— 7.6	4	16.6	6	7	20	9	8	3	22	4
W Virginis	13	20.9	— 2	52	8.7—10.4	17	06.5	9	13	26	19	13	2	30	8
SS Hydræ		25.0	—23	08	7.4— 8.1	8	04.8	11	22	28	7	13	17	30	3
RV Urs. Maj.	13	29.4	+54	31	9.2— 9.9	0	11.2	5	10	24	4	11	21	30	14
ST Virginis	14	22.5	— 0	27	10.3—11.4	0	09.9	7	6	23	16	9	2	25	12
V Centauri		25.4	—56	27	6.4— 7.8	5	11.9	3	13	25	12	5	12	21	23
RS Bootis	14	29.3	+32	11	8.9—10.0	0	09.1	6	22	22	0	6	2	21	4
R Trian. Austr.	15	10.8	—66	08	6.7— 7.4	3	09.3	5	19	22	18	5	7	22	6
S Trian. Austr.	15	52.2	—63	29	6.4— 7.4	6	07.8	3	18	22	17	4	8	23	8
S Normæ	16	10.6	—57	39	6.6— 7.6	9	18.1	7	21	27	9	6	3	25	15
RW Draconis		33.7	+58	03	9.6—10.8	0	10.6	5	8	25	6	7	13	20	20
RV Scorpii	16	51.8	—33	27	6.7— 7.4	6	01.5	7	8	25	13	6	16	24	20
X Sagittarii	17	41.3	—27	48	4.4— 5.0	7	00.3	5	3	19	4	9	5	23	5
Y Ophiuchi		47.3	— 6	07	6.1— 6.5	17	02.9	10	19	27	22	14	1	31	4
W Sagittarii	17	58.6	—29	35	4.3— 5.1	7	14.3	8	7	23	11	7	16	22	21
Y Sagittarii	18	15.5	—18	54	5.4— 6.2	5	18.6	6	12	23	19	10	3	21	16
U Sagittarii		26.0	—19	12	6.5— 7.3	6	17.9	9	6	22	18	5	5	18	17
Y Scuti		32.6	— 8	27	8.7— 9.2	10	08.3	5	11	26	4	5	12	26	5
RZ Lyræ		39.9	+32	42	9.9—11.2	0	12.3	9	22	25	6	9	15	24	3
RT Scuti		44.1	—10	30	9.1— 9.7	0	11.9	11	16	26	12	10	9	25	6
κ Pavonis	18	46.6	—67	22	3.8— 5.2	9	02.2	11	4	29	8	7	11	25	15

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of Maxima in 1928							
					July				August			
	h m	° ′		d h	d h		d h		d h		d h	
U Aquilæ	19 24.0	— 7 15	6.2— 6.9	7 00.6	5 17		19 18		9 20		23 21	
XZ Cygni	30.4	+56 10	8.6— 9.3	0 11.2	7 4		21 4		4 4		25 4	
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	6 16		22 15		7 15		23 14	
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	7 23		19 12		7 18		23 3	
η Aquilæ	47.4	+ 0 45	3.7— 4.5	7 04.2	6 19		21 3		4 11		18 20	
S Sagittæ	51.5	+16 22	5.6— 6.4	8 09.2	11 15		28 9		5 18		22 12	
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	4 19		23 18		5 10		24 9	
X Cygni	20 59.5	+35 14	6.0— 7.0	16 09.3	0 18		17 4		2 13		18 22	
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	8 0		21 7		8 1		21 8	
UY Cygni	52.3	+30 03	9.6—10.4	0 13.5	8 21		25 17		11 12		22 18	
RV Capric.	55.9	—15 37	9.2—10.1	0 10.7	6 6		19 16		6 14		24 12	
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	10 21		25 14		9 7		24 0	
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	9 13		25 6		10 0		25 17	
SW Aquarii	10.2	— 0 20	9.9—10.8	0 11.0	6 13		20 8		7 17		21 12	
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	9 23		24 13		8 3		22 17	
Y Lacertæ	22 05.2	+50 33	9.1— 9.6	4 07.8	8 14		21 13		7 21		25 4	
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	6 16		22 18		7 21		23 23	
Z Lacertæ	36.9	+56 18	8.2— 9.0	10 21.1	7 6		29 0		8 22		30 16	
RR Lacertæ	37.5	+55 55	8.5— 9.2	6 10.1	8 10		21 6		3 2		22 8	
V Lacertæ	44.5	+55 48	8.5— 9.5	4 23.6	10 0		24 23		8 21		23 20	
X Lacertæ	22 45.0	+55 54	8.2— 8.6	5 10.7	11 21		28 5		8 2		24 10	
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	8 14		24 22		10 5		21 2	
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	6 18		25 15		7 5		19 19	
RY Cassiop.	23 47.2	+58 11	9.3—11.8	12 03.4	9 9		21 12		2 16		26 22	

Monthly Report of the American Association of Variable Star Observers, for the Month of April, 1928.

In spite of the prevailing cloudy weather of the month under consideration, the returns are quite encouraging; one third more observations having been received than during the corresponding month of 1927. Mr. B. S. Whitney, of the University of Oklahoma, contributes his first list to our reports.

S Apodis, *145971*, has further decreased to minimum, present magnitude 13, and should be diligently watched during the next few months. Nova Pictoris, *063462*, in view of the recent interest aroused through becoming double, should be even more closely watched than usual. It has already reached the 7th magnitude in its gradual decline to normalcy. SU Tauri, 054319, R Cor. Bor., 154428, and RY Sagittarii, *191033*, appear to be enjoying periods of quiescence, having remained at normal maximum brilliance for several months past.

Will all contributors to these columns of observations, kindly see that their monthly reports are in the hands of the recording secretary on or before the 15th of each month, even though their lists may not cover the calendar month in question? By ascertaining the time required for the reports to reach Cambridge, this can be done with comparative ease. We desire to have our reports contain observations as up-to-date as possible, and when they are reported three to six months old, our columns suffer thereby.

Variable Star Observations Received During April, 1928.

Feb. 0 = J.D. 2425277; Mar. 0 = J.D. 2425306; Apr. 0 = J.D. 2425337.

J.D.Est.Obs.

V Scl
000339
282 11.4 Bl
299 12.1 Bl

S Scl
001032
282 10.6 Bl
284 11.0 En
287 11.1 Sm
291 11.3 En
293 11.3 Dr
294 11.3 Dr
295 11.2 Dr
295 11.6 Sm
299 11.3 Bl
300 11.4 Dr

X And
001046
286 14.8 Bf
295[14.6 Bf

T And
001726
300 10.4 Ch

T Cas
001755
311 9.6 Wk
318 10.8 Wk
320 9.3 B
325 9.8 Wk
326 9.5 Jo
326 9.0 Pt
334 10.6 Wk
336 9.0 L
337 9.8 Kz
337 9.7 Eb

R And
001838
294[10.6 Wy

S Tuc
001862
283 9.2 Bl
287 9.3 Sm
287 9.6 En
291 9.7 En
296 9.0 Sm
299 9.1 Bl
304 9.6 En

T Phe
002546
283 9.4 Bl
284 9.0 En
287 9.0 Sm
291 9.2 En
296 9.0 Sm
299 9.1 Bl

W Scl
002833
300 13.0 Bl

J.D.Est.Obs.

U Cas
004047
326 12.4 Pt
334 11.4 Wk

V And
004435
286 11.1 Bf
291 11.7 Bg
295 11.7 Bf

X Scl
004435
300 13.1 Bl

RR And
004533
286 13.2 Bf
291 13.1 Bg
300 12.8 Bf

— Cas
004746b
326 10.5 Pt

W Cas
004958
326 11.6 Pt

U Tuc
005475
287[12.9 En
292[12.9 Sm
300 13.0 Bl

U Scl
010630
294[12.0 Dr
300[13.2 Bl
314[11.8 Dr

U And
010940
316 9.2 Lg
326 10.9 Lg

S Cas
011272
316[13.2 Ch

RZ Per
012350
320 10.1 B
326 9.9 By
329 10.2 By
329 10.4 Sp
333 10.2 By
337 9.1 Eb
337 9.2 Kz
347 10.8 Sp

R Psc
012502
286 8.2 Bf
295 8.2 Bf

RU And
013238
320 12.8 B
326 13.6 Pt
326 13.7 Lg

J.D.Est.Obs.

Y And
013338
326 13.7 Pt

X Cas
014958
319 11.1 B
326 10.6 Pt
343 10.7 Bn

U Per
015254
320 8.4 B
321 8.4 Ch
326 8.0 Pt
337 10.7 Eb
337 10.6 Kz

S Ari
015912
326 11.3 Pt

R Ari
021024
316 12.5 Ch
326 12.0 Pt

W And
021143a
300 7.8 Ch
321 7.4 Ch
326 7.3 Pt

T Per
021258
300 8.9 Ch
321 8.9 Ch
326 8.6 Pt

o Cet
021403
257 7.1 H
259 7.1 H
261 7.4 H
271 8.0 H
283 7.8 H
285 7.9 H
287 8.0 En
288 8.0 H
291 8.5 En
300 8.8 Ch
316 9.2 Ch
326 9.2 Pt

S Per
021558
300 9.3 Ch
320 9.3 B
321 9.1 Ch
326 9.7 By
326 8.8 Pt
329 9.8 By
333 9.7 By
339 9.6 By
353 9.7 By

J.D.Est.Obs.

R Cet
022000
316 10.3 Ch
321 10.2 Ch

RR Per
022150
321[13.5 B

R For
022426
283 9.2 Bl
300 9.5 Bl

U Cet
022813
300 8.5 Ch

R Tri
023133
257 9.1 H
261 9.1 H
320 11.4 Ch
321 11.3 GC
326 11.5 Pt
326 11.6 Sf
343 11.7 Sf

W Per
024356
319 9.8 B
321 10.1 Ch
326 9.4 Pt
337 9.3 B
337 10.0 Eb
337 9.8 Kz
350 9.5 Cl

R Hor
025050
283 5.5 Bl
284 5.1 En
285 5.8 Ht
287 5.6 Sm
290 6.0 Ht
291 5.6 En
296 5.1 Sm
296 5.8 Ht
300 5.6 Bl
300 6.1 En
305 6.6 Ht
306 6.1 Sm
325 7.0 Dr
328 7.1 Dr
331 7.2 Dr

T Hor
025751
283 10.6 Bl
287 11.5 Sm
296 12.2 Sm
300 12.4 Bl

U Ari
030514
286 14.6 Bf
291 14.2 Bg

J.D.Est.Obs.

U Ari
030514
295 14.2 Bf

X Cet
031401
326 11.8 Pt

Y Per
032043
319 9.6 B
320 9.4 Ch
326 8.9 Pt
337 10.5 Eb
337 10.6 Kz

R Per
032335
316 13.8 Lg
326 13.0 Lg
343 11.5 Lg

U Cam
033362
327 8.0 By
355 7.6 By

T Eri
035124
300[12.2 Dr
313[11.3 Dr
317[12.2 Dr
326[12.2 Dr
331[12.2 Dr

V Eri
035916
327 9.3 By

T Tau
041619
326 10.2 By
327 10.5 By
329 10.4 By
333 10.2 By
339 10.2 By
353 10.2 By
356 10.2 By

R Tau
042209
286 10.4 Bf
295 10.3 Bf
315 11.0 Ch
321 11.5 B
326 12.0 Pt
344 12.6 B

W Tau
042215
320 10.2 GC
321 10.3 B
326 10.0 Jo
326 9.8 Pt
337 9.8 Kz
337 10.0 Eb
329 9.6 Sp
340 9.8 B

J.D.Est.Obs.

W Tau
042215
352 9.8 Al
353 9.1 Sp

S Tau
042309
286[14.8 Bf
295[14.8 Bf

T Cam
043065
316 13.7 Lg
326 13.3 Lg
326 12.8 Pt
327 12.4 GC
337 11.9 GC
343 11.0 Lg
344 10.6 GC

RX Tau
043208
321 13.0 B
326 13.6 Pt
343[13.0 Sf

R Ret
043263
283 8.2 Bl
284 9.0 En
285 9.0 Ht
287 8.7 Sm
290 9.2 Ht
291 9.0 En
296 9.7 Ht
300 9.5 Bl
305 10.0 Ht
306 10.4 Sm

X Cam
043274
320 11.4 Wk
320 12.8 Ch
326 11.7 Wk
326 12.8 Pt
329 12.5 Wy
329 12.6 Wl

R Dor
043562
283 5.5 Bl
284 5.5 En
285 5.5 Ht
287 5.8 Sm
290 5.5 Ht
291 5.5 En
296 5.5 Ht
300 5.8 Bl
306 5.5 Sm

R Cae
043738
288[12.0 En
290[12.0 Ht
292[12.2 En
296[12.0 Sm

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1928.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
R CAE			T LEP			S AUR			T ORI			Y TAU			S COL		
043738			*050022*			052034			*053005a*			053920			*054331*		
305	12.0	Ht	283	8.1	Bl	316	8.6	Ch	329	10.0	Pt	327	7.2	By	306	10.8	Sm
313	10.9	Dr	288	8.5	Bf	320	8.8	GC	333	10.0	Pt	355	7.2	By	Z TAU		
322	11.7	Dr	300	8.7	Bf	321	8.9	B	333	10.1	Sp	SU TAU			054615a		
333	11.5	Dr	300	8.2	Bl	335	9.0	Ch	335	10.1	An	054319			288	13.2	Bf
R PIC			326	9.5	Pt	326	8.2	Pt	335	10.3	Gt	313	9.4	An	300	13.1	Bf
044349			329	10.1	B	326	9.0	Wl	335	10.3	L	313	9.5	Gt	326	14.0	GC
283	7.0	Sm	S PIC			329	9.1	Sp	336	9.9	L	316	9.5	Lg	349	12.7	GC
285	7.0	Ht	*050848*			337	9.0	Kz	338	10.0	Sp	318	9.4	Lg	RV TAU		
287	7.0	En	287	12.2	En	337	9.1	Eb	339	9.9	GC	318	9.8	Ch	054615b		
290	7.2	Ht	296	12.9	Sm	337	9.2	GC	340	10.1	B	319	9.5	Lg	288	12.4	Bf
291	6.5	En	300	13.4	Bl	338	9.1	Sp	345	10.2	Pt	322	9.8	Ch	300	12.4	Bf
291	7.2	Dr	R AUR			340	8.8	B	346	10.3	Pt	322	9.4	An	RU TAU		
294	7.2	Dr	050953			345	8.8	GC	347	10.3	Pt	324	9.5	An	054615c		
296	7.3	Ht	321	8.6	B	353	9.3	Sp	347	10.2	Sp	325	9.8	Ch	326	12.8	GC
296	7.0	Sm	325	9.1	Ch	W AUR			348	10.2	Pt	326	9.6	Pt	349	10.6	GC
300	7.2	Dr	326	8.6	Pt	052036			353	10.0	Sp	326	9.3	By	R COL		
300	6.5	Sm	329	9.6	Wl	316	10.0	Ch	AN ORI			326	9.4	Lg	*054620*		
305	7.3	Ht	337	9.2	Kz	321	9.1	B	*053005f*			327	9.7	Pt	283	8.8	Bl
311	6.8	Dr	337	9.4	En	325	8.8	Ch	336	11.0	L	328	9.7	Pt	285	9.0	Ht
313	6.7	Dr	339	8.8	Al	326	9.1	Wl	S CAM			329	9.8	Pt	288	8.6	En
317	7.2	Dr	340	9.2	B	326	8.5	Pt	053068			329	9.5	B	290	9.2	Ht
319	7.3	Dr	352	9.4	Al	326	9.0	By	318	8.8	Wk	329	9.6	Sp	292	9.3	En
322	7.3	Dr	T PIC			327	9.0	By	324	9.2	GC	329	9.4	By	296	9.2	Sm
323	7.3	Dr	*051247*			327	8.6	Jo	325	9.4	Wk	330	9.7	Pt	296	9.0	Ht
324	7.3	Dr	283	10.7	Bl	329	8.6	By	325	8.9	Ch	333	9.7	Pt	301	9.2	Bl
325	7.4	Dr	285	10.9	Ht	333	8.6	By	326	8.6	Pt	334	9.2	By	306	9.3	Sm
326	7.3	Dr	287	10.2	En	335	8.0	L	337	9.1	GC	335	9.4	An	305	9.2	Ht
331	7.5	Dr	290	11.6	Ht	337	8.5	Kz	349	9.0	GC	335	9.6	L	U ORI		
333	7.5	Dr	291	11.2	En	337	8.5	Eb	RR TAU			337	9.4	Kz	054920a		
336	7.6	Dr	294	11.5	Dr	339	8.5	By	053326			337	9.7	Eb	322	11.2	Ch
V TAU			296	11.8	Sm	340	8.3	B	288	13.1	Bf	338	9.5	Cl	323	10.5	Gb
044617			296	11.8	Ht	353	8.6	By	300	13.9	Bf	339	9.3	By	326	10.8	By
315	13.1	Ch	300	11.6	Bl	356	8.9	By	304	13.2	Bf	342	9.7	Sf	326	11.0	Fd
316	13.0	Lg	300	12.1	Dr	S ORI			304	13.2	Bg	343	9.5	Lg	326	12.0	Wl
320	13.8	GC	326	12.5	Dr	*052404*			319	12.5	B	344	9.6	B	327	11.5	Fd
326	13.3	Pt	331	12.5	Dr	318	11.5	Wk	320	12.7	GC	344	9.8	Cl	328	11.3	Fd
326	13.8	Lg	T COL			319	9.5	B	337	12.5	GC	345	9.7	Pt	328	10.0	Gb
343	13.9	Lg	*051533*			322	9.7	An	337	12.6	B	346	9.6	Pt	329	10.1	B
345	14.0	GC	283	8.8	Bl	325	12.0	Wk	RU AUR			346	9.8	Cl	337	11.2	Al
R ORI			285	9.7	Ht	326	9.2	Pt	053337			347	9.6	Cl	344	11.3	B
045307			288	9.7	En	326	9.3	GC	326	11.7	Wl	347	9.7	Sp	345	10.6	Fd
326	12.3	B	290	10.0	Ht	337	8.8	B	326	11.5	Pt	347	9.6	Pt	352	11.6	Al
344	12.5	B	292	9.5	En	339	8.3	Al	326	11.6	By	348	9.7	Pt	354	11.2	Fd
R LEP			294	10.1	Dr	339	9.5	GC	327	11.1	GC	350	9.8	Cl	UW ORI		
045514			296	10.5	Sm	352	8.8	Al	337	11.8	GC	351	9.8	Sf	054920b		
303	9.5	Ch	296	10.7	Ht	353	9.5	By	342	12.4	Sf	353	9.6	Sp	337	10.6	Kz
314	9.6	Ch	300	10.6	Bl	T ORI			345	11.6	GC	353	9.3	By	337	10.5	Eb
325	9.2	Bu	300	10.4	Dr	*053005a*			348	12.5	Pt	356	9.2	By	347	10.0	Wd
326	9.4	Ch	305	11.0	Ht	313	10.2	An	352	12.7	Sf	S COL			Z AUR		
326	8.0	Jo	306	10.9	Sm	313	10.2	Gt	U AUR			*054331*			055353		
326	7.6	Pt	317	11.1	Dr	321	10.3	B	053531			283	10.2	Bl	318	10.5	Ch
328	8.2	Jo	319	11.3	Dr	322	9.3	An	316	11.6	Ch	285	10.4	Ht	319	10.3	B
329	9.0	B	322	11.3	Dr	324	9.9	An	319	11.1	B	288	10.5	En	325	10.4	Ch
335	7.9	L	323	11.3	Dr	324	9.8	GC	325	11.8	Ch	290	10.7	Ht	326	11.4	Pt
V ORI			324	11.3	Dr	326	10.0	Pt	326	11.7	Pt	292	10.8	En	327	11.2	Pt
050003			325	11.4	Dr	327	10.0	Pt	327	11.8	Sf	296	10.6	Sm	327	9.7	By
319	13.5	B	326	11.5	Dr	327	10.7	GC	337	11.6	B	296	10.8	Ht	328	11.2	Pt
326	13.6	Pt	328	11.6	Dr	328	9.9	Pt	345	12.2	Sf	301	11.2	Bl	329	11.1	Pt
343	13.7	Lg	331	11.6	Dr	328	9.8	GC	352	11.2	Sf	305	11.1	Ht	329	9.6	By

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1928.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
Z AUR	U LYN	R GEM	L_2 PUP	T CMI	W PUP
055353	063159	070122a	*071044*	072811	*074241*
330 11.2 Pt	327 13.8 B	303 8.7 Ch	322 4.3 Dr	316 10.0 Lg	287 11.2 Sm
333 11.0 Pt	R MON	321 9.8 Sw	324 4.3 Dr	326 11.0 Lg	288 11.0 En
334 9.7 By	063308	324 9.5 Ch	325 4.2 Dr	326 9.9 Pt	290 11.2 Ht
337 9.6 Al	327 11.2 Wl	326 9.4 Pt	326 4.3 Dr	327 10.6 Wl	292 10.9 En
337 10.0 Kz	327 11.9 B	326 9.8 Jo	328 4.2 Dr	335 10.6 B	296 10.6 Ht
337 9.8 Eb	Nov PIC	326 10.0 Wl	331 4.1 Dr	343 11.7 Lg	302 10.0 Bl
338 9.9 Pt	*063462*	329 9.6 Wd	333 4.0 Dr	347 11.0 Sp	305 10.6 Ht
339 9.7 By	285 6.9 Ht	329 10.0 Sp	336 4.2 Dr	353 11.3 Sp	306 10.5 Sm
340 9.7 B	288 6.8 En	333 9.9 Wd	RR MON	X PUP	T GEM
345 9.7 Pt	290 6.9 Ht	334 9.3 Al	071201	*072820a*	074323
346 9.8 Pt	291 6.8 En	337 9.8 Al	318 10.0 Lg	326 8.3 By	326[13.6 Wl
347 9.5 Pt	296 6.9 Ht	337 10.2 Wd	318 9.9 Ch	Z PUP	327[13.8 B
348 9.8 Pt	305 6.9 Ht	337 10.3 Kz	326 10.5 By	*072820b*	349 12.2 GC
348 10.1 Pt	S LYN	337 10.1 Eb	326 10.3 Lg	288 7.9 Bf	U PUP
352 9.8 Al	063558	343 10.1 Al	327 11.0 By	295 7.9 Bf	*075612*
353 9.7 By	319 10.8 Ch	345 10.4 Jo	329 11.0 By	300 8.4 Bf	318[13.5 Lg
356 9.6 By	326 10.5 Pt	347 10.5 Pn	332 11.1 Lg	326 8.5 By	321 13.7 B
R OCT	327 10.5 B	350 10.3 Al	333 11.3 By	329 8.9 By	327[13.9 GC
055686	329 10.6 Wl	353 10.9 Sp	339 11.3 By	334 9.2 By	343[12.6 GC
283 11.2 Bl	X GEM	Z GEM	343 11.8 Lg	339 10.0 By	R CNC
295 11.0 Sm	064030	070122b	343 11.5 Sf	353 10.3 By	081112
301 11.2 Bl	326 10.1 GC	326 12.4 Pt	347 11.2 Pn	S VOL	303 8.7 Ch
S LEP	326 10.6 Wl	TW GEM	353 11.5 By	*073173*	320 7.9 Wk
060124	329 10.3 Sp	070122c	V GEM	283 11.4 Bl	321 8.1 Ch
327 7.2 By	337 10.7 Eb	326 8.0 Pt	071713	285 11.1 Ht	326 7.0 Wk
X AUR	337 10.5 Kz	337 8.4 Eb	316 10.0 Lg	287 10.9 En	326 7.4 Pt
060450	340 10.6 B	337 8.0 Kz	326 9.9 Lg	290 10.7 Ht	326 8.3 Fd
320 13.0 Ch	343 10.7 Bn	343 8.0 Al	326 9.7 GC	291 11.4 En	327 8.3 Fd
321 13.3 B	353 11.2 Sp	350 7.8 Al	326 9.1 Pt	294 11.0 Dr	327 7.5 Jo
326 12.8 Pt	W MON	R CMI	327 9.6 Wl	296 11.4 Sm	328 8.3 Fd
329 12.0 Wl	*064707*	070310	327 9.5 B	296 10.7 Ht	329 8.2 Fd
334 11.0 Cl	326 9.8 Pt	322 11.0 An	343 8.9 Lg	301 10.9 Bl	333 8.0 Fd
339 11.6 Al	335 9.6 B	323 11.5 Lg	349 8.8 GC	305 10.5 Ht	336 8.0 Fd
345 11.6 GC	Y MON	327 10.9 By	353 8.7 By	317 9.2 Dr	340 6.7 B
352 11.9 Al	065111	327 11.5 Wl	356 8.5 By	322 9.2 Dr	345 7.0 Jo
V AUR	316 13.5 Lg	335 10.5 B	S CMI	324 9.1 Dr	345 7.8 Fd
061647	326 13.4 Lg	336 10.9 L	072708	325 9.1 Dr	346 7.5 Fd
321 11.0 B	327 13.5 B	343 11.6 Lg	313 9.6 Ch	328 9.1 Dr	346 7.2 Gs
329 11.0 Wl	327 13.5 Wl	344 11.0 Cl	324 9.9 Ch	331 9.1 Dr	347 7.2 Fd
329 11.2 Sp	343 12.9 Lg	355 10.9 By	325 10.1 Fd	333 9.0 Dr	350 6.3 Jo
340 10.0 B	X MON	R VOL	326 10.2 Fd	336 9.0 Dr	354 7.2 Fd
353 10.9 Sp	*065208*	*070772*	326 10.2 Jo	U CMI	Z CAM
V MON	319 7.9 Bu	287[12.6 En	327 10.0 Wl	073508	081473
061702	319 8.0 Ch	291[12.6 En	327 10.3 Fd	322 11.4 An	315 11.5 L
319 10.9 Ch	325 7.7 Bu	296[12.6 Sm	328 10.5 Fd	326 11.2 Pt	336 11.3 L
326 11.0 Pt	335 7.4 L	305[12.6 Ht	329 10.4 Fd	327 11.2 Wl	336 11.3 Gt
327 11.6 By	R LYN	317[11.3 Dr	333 10.5 Fd	327 11.2 B	V CNC
AG AUR	063355	322[11.8 Dr	334 10.2 Al	336 10.8 L	081617
062047	329[13.5 Wl	333[11.8 Dr	335 9.9 B	S GEM	303 9.2 Ch
315 9.7 L	349[13.5 GC	L_2 PUP	336 10.6 Fd	073723	321 10.5 Sw
335 10.5 L	V CMI	*071044*	337 10.3 Eb	326[13.6 Wl	325 10.0 Ch
Z MON	070109	293 4.1 Dr	337 10.1 Kz	326[13.6 GC	326 10.1 Pt
062808	319[13.8 B	294 4.4 Dr	343 10.6 Al	349 13.6 GC	340 10.9 B
326 8.8 By	327[13.0 Wl	295 4.1 Dr	345 10.5 Jo	353 12.4 Pi	353[11.9 Pi
355 8.5 By	343 13.3 Lg	300 4.3 Dr	345 10.8 Fd	W PUP	RT HYA
	R GEM	313 4.3 Dr	347 10.7 Fd	*074241*	*082405*
	070122a	317 4.2 Dr	350 10.6 Al	283 11.4 Bl	326 8.3 Pt
	274 7.1 H	319 4.2 Dr	354 10.8 Fd	285 11.6 Ht	

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1928.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R CHA	T PYX	R CAR	R LEO	S CAR	R UMA
082476	*090031*	*092962*	094211	*100661*	103769
283 8.4 Bl	302 [11 Bl	319 5.2 Dr	328 9.5 Fd	283 8.9 Bl	299 11.1 Ch
287 9.5 Sm	V UMA	322 5.0 Dr	329 9.6 Fd	284 9.1 En	321 9.6 Ch
287 9.5 En	090151	323 4.8 Dr	329 9.0 GC	285 9.5 Ht	321 9.8 Sw
291 9.0 En	314 10.0 Wy	X HYA	329 9.4 Wd	287 8.6 Sm	325 10.1 Wk
296 9.0 Sm	322 9.9 An	*093014*	333 9.7 Wd	290 9.3 Ht	326 9.0 B
301 8.1 Bl	323 9.8 Wy	288 12.8 Bf	333 9.7 Fd	291 8.7 En	326 8.8 Pt
304 8.4 En	336 10.1 L	290 12.8 Bf	334 9.4 Wk	293 8.5 Dr	327 9.7 Fd
306 8.4 Sm	336 10.1 Gt	295 12.9 Bf	334 8.9 Al	294 8.4 Dr	328 9.4 Fd
U CNC	W CNC	297 12.9 Bf	335 9.4 An	295 8.4 Dr	329 8.8 Fd
083019	090425	304 12.6 Bg	335 9.1 Gt	295 8.6 Sm	329 9.0 Wd
326 13.0 Lg	315 12.6 L	315 13.2 Ch	335 9.3 Fd	296 8.7 Ht	333 8.8 Wd
353[10.9 Pi	318 12.0 Lg	318 12.4 Lg	336 9.9 Fd	300 8.3 Dr	333 8.5 Fd
X UMA	330 11.0 Lg	321 12.7 B	343 9.1 Al	301 8.1 Bl	334 10.3 Wk
083350	345 10.4 Sf	330 12.6 Lg	345 9.6 Fd	304 8.3 En	336 8.4 Fd
326 12.6 Pt	350 10.0 Al	346 12.3 Cl	345 9.0 Jo	305 8.1 Ht	338 8.5 Fd
RV HYA	353 8.8 Pi	Y DRA	346 9.6 Fd	306 8.3 Sm	339 8.1 Al
083409	RW CAR	093178	347 9.7 Fd	311 7.9 Dr	345 7.8 Fd
327 8.5 By	*091868*	300 11.6 Ch	347 9.6 Wd	313 7.9 Dr	346 7.9 Fd
355 8.2 By	288 12.8 En	314 11.4 Ch	347 9.9 GC	317 7.8 Dr	346 8.0 Gs
S HYA	292 12.8 En	318 10.2 Wk	349 9.5 Fd	319 7.5 Dr	347 7.8 Fd
084803	294 11.8 Dr	318 10.7 Lg	350 9.7 Jo	323 7.0 Dr	348 7.7 Fd
303 9.7 Ch	302 13.0 Bl	319 10.6 Ch	353 10.3 Pi	324 7.0 Dr	349 7.9 Fd
318 10.8 Lg	336[11.4 Dr	320 10.2 Wk	354 9.6 Fd	326 6.9 Dr	350 8.5 Wd
320 10.9 Wk	Y VEL	321 10.7 Ch	X LEO	328 6.9 Dr	350 8.2 Pi
322 11.0 Ch	*092551*	325 10.4 Wk	094512	331 6.8 Dr	353 8.4 By
326 10.9 Jo	283 9.7 Bl	326 10.5 Wk	322[13.3 An	333 6.7 Dr	353 7.8 Gs
326 11.2 Pt	287 9.5 Sm	326 9.4 Jo	Y HYA	336 6.5 Dr	V HYA
329 12.0 GC	288 9.2 En	326 10.7 Pt	*094622*	U UMA	*104620*
330 11.6 Lg	292 9.5 En	326 11.3 Fd	326 6.6 Pt	100860	283 8.5 Bl
X CNC	294 8.9 Dr	327 11.1 GC	339 7.1 By	339 6.7 By	299 9.4 Ch
084917	296 9.5 Sm	329 11.1 Fd	Z VEL	355 6.6 By	301 9.4 Ch
329 6.3 By	300 9.2 Dr	343 8.8 Al	*094953*	Z CAR	301 8.9 Bl
355 6.3 By	301 9.0 Bl	345 8.8 Jo	287[12.8 Sm	*101058*	315 8.7 L
T HYA	306 9.0 Sm	346 7.0 Gs	292 12.8 En	288[12.3 En	320 9.6 Ch
085008	317 9.1 Dr	347 9.2 GC	294[12.1 Dr	292[12.3 En	325 9.7 Ch
303 10.2 Ch	322 9.2 Dr	348 8.3 Fd	302 13.0 Bl	296[12.3 Sm	326 8.5 Pt
318 11.1 Lg	326 9.2 Dr	349 8.1 Fd	305 12.8 Ht	302[12.6 Bl	RS HYA
322 11.3 Ch	333 9.9 Dr	350 8.0 Jo	319[12.1 Dr	319[11.8 Dr	*104628*
322 11.4 An	336 10.4 Dr	353 8.1 Pi	328[12.1 Dr	328[11.4 Dr	302 12.1 Bl
326 11.8 Pt	R CAR	353 7.7 Gs	V LEO	W VEL	W LEO
329 12.2 GC	*092062*	R LEO	095421	*101153*	104814
330 11.7 Lg	283 6.9 Bl	094211	315 13.2 Ch	283 9.5 Bl	297 14.5 Bf
334 13.3 GC	284 7.6 En	274 8.0 H	320[12.4 GC	287 9.6 Sm	316[13.2 Ch
335 11.5 B	285 6.9 Ht	275 8.0 H	322 13.3 Ch	296 9.6 Sm	323[14.0 Lg
347 13.0 GC	287 6.8 Sm	276 7.9 H	326 13.3 B	301 9.3 Bl	326[13.8 B
T CNC	290 6.8 Ht	285 8.0 H	326 13.2 Pt	306 9.7 Sm	RS CAR
085120	291 6.7 En	286 8.0 H	327 13.4 GC	U HYA	*110361*
303 9.5 Ch	293 6.9 Dr	289 8.0 H	RV CAR	*103212*	288[12.3 En
326 8.7 Pt	295 6.7 Dr	300 8.8 Ch	*095563*	274 5.5 H	296[12.3 Sm
329 9.7 By	295 6.4 Sm	318 9.2 Wk	302 13.8 Bl	276 5.8 H	306[12.3 Sm
353 10.0 Pi	296 6.6 Ht	321 9.5 Ch	319[12.5 Dr	336 4.7 Gt	S LEO
355 9.9 By	300 6.3 Dr	322 9.2 An	324 11.6 Dr	336 4.7 L	110506
Y HYA	301 6.2 Bl	325 9.1 Wk	328 11.6 Dr	RZ CAR	316[12.9 Ch
090024	304 5.9 En	325 9.4 Fd	RY LEO	*103270*	320 12.7 B
327 12.9 GC	305 6.2 Ht	326 8.5 Pt	095814	319[12.1 Dr	323 11.8 Lg
347 12.5 GC	306 6.0 Sm	326 9.5 Fd	324 9.3 Kl	336[11.8 Dr	350 11.6 Cl
	311 5.7 Dr	326 8.9 Jo	326 9.2 Kl		
	317 5.3 Dr	327 9.4 Fd	329 9.1 Kl		

Star J.D.	Est.Obs	J.D.	Est.Obs.	Star J.D.	Est.Obs.	J.D.	Est.Obs.
J.D.Est.Obs.	**J.D.Est.Obs.**	**J.D.Est.Obs.**		**J.D.Est.Obs.**	**J.D.Est.Obs.**	**J.D.Est.Obs.**	
RY CAR	R CRV	T UMA		S UMA	S VIR	RR VIR	
111561	*121418*	123160		123961	*132706*	*135908*	
302 12.2 Bl	290 10.5 Bf	345 8.8 Jo		350 8.7 Jo	345 9.5 Wm	331 11.3 Lg	
319 11.6 Dr	297 9.9 Bf	347 10.0 Wd		354 9.1 Pi	347 9.0 Sp	333 12.5 Pt	
323 11.4 Dr	320 8.1 B	350 8.6 Jo		RU VIR	353 8.8 Sp	Z VIR	
328 11.6 Dr	325 8.4 Wk	354 9.0 Pi		124204	RV CEN	*140512*	
RS CEN	325 8.0 Bu	R VIR		326 12.5 Pt	*133155*	353 11.3 Sp	
111661	326 8.0 Pt	123307		326 12.4 B	283 8.1 Bl	RU HYA	
296[12.7 Sm	335 7.9 B	321 10.7 Ch		330 13.0 Lg	289 7.0 Ht	*140528*	
302 13.2 Bl	337 8.2 Wd	325 10.5 Wk		U VIR	296 6.7 Ht	302 10.6 Bl	
319 12.1 Dr	347 8.3 Wd	326 10.7 Pt		124606	302 8.3 Bl	R CEN	
323 11.1 Dr	350 8.0 Cl	335 11.3 B		325 8.9 Wk	305 6.2 Ht	*140959*	
328 10.6 Dr	SS VIR	337 11.2 Eb		326 8.5 Pt	317 7.9 Dr	283 8.8 Bl	
333 9.7 Dr	122001	337 11.4 Kz		330 8.7 Lg	326 8.0 Dr	289 8.9 Ht	
336 9.2 Dr	332 8.7 B	RS UMA		334 9.2 Al	328 8.0 Dr	292 8.3 En	
X CEN	T CVN	123459		335 8.9 B	333 8.0 Dr	293 8.6 Dr	
114441	122532	290 10.0 Bf		337 8.9 Kz	T UMI	295 8.6 Dr	
302 8.3 Bl	321 9.9 Ch	297 10.2 Bf		337 8.9 Eb	133273	296 8.9 Sm	
W CEN	326 9.4 Pt	315 10.3 Ch		345 9.1 Al	327 12.0 Fd	300 8.5 Dr	
115058	328 9.9 Fd	320 10.4 Ch		RV VIR	329 12.0 Fd	302 8.7 Bl	
283 9.2 Bl	329 10.4 Fd	326 10.0 Jo		*130212*	T CEN	305 8.8 Ht	
287 9.3 Sm	334 10.1 Al	326 10.5 Fd		330[14.1 Lg	*133633*	305 7.8 En	
287 9.9 Ht	343 9.7 Al	326 10.6 Pt		U OCT	283 7.2 Bl	306 7.8 Sm	
288 9.4 En	345 9.0 Jo	329 10.8 Fd		*131283*	293 7.2 Dr	317 7.1 Dr	
292 9.5 En	346 9.5 Cl	336 10.8 Wd		283 10.6 Bl	294 6.8 Dr	324 6.4 Dr	
296 10.9 Ht	350 9.4 Jo	337 10.4 Wd		287 10.8 En	295 6.6 Dr	325 6.3 Dr	
296 11.0 Sm	353 10.0 Gs	337 11.1 Al		287 10.5 Sm	300 6.3 Dr	328 6.2 Dr	
302 11.0 Bl	353 9.8 Pi	345 11.3 Al		287 10.8 Ht	302 6.2 Bl	333 6.0 Dr	
304 11.2 En	Y VIR	347 10.8 Wd		291 10.8 En	305 6.3 Bl	336 6.0 Dr	
305 11.2 Ht	*122803*	350 10.4 Jo		296 11.2 Sm	317 6.0 Dr	U UMI	
306 11.7 Sm	290 9.4 Bf	354 12.6 Pi		296 11.2 Ht	319 6.0 Dr	141567	
R COM	297 9.4 Bf	Y UMA		302 11.4 Bl	324 6.0 Dr	301 11.2 Ch	
115919	330 10.0 Lg	123556		324[11.2 Dr	326 6.1 Dr	319 11.8 Ch	
316 11.5 Ch	335 10.6 B	327 9.4 By		326[12.4 Dr	328 6.0 Dr	320 11.9 Wk	
323 11.1 Lg	337 10.6 Eb	353 8.6 By		W VIR	333 6.1 Dr	326 11.8 Wk	
325 10.9 Wy	337 10.7 Kz	S UMA		*132002*	336 6.1 Dr	326 12.0 Pt	
325 11.0 Wk	U CEN	123961		330 9.4 Lg	RT CEN	339 11.6 Al	
326 10.4 B	*122854*	315 11.1 Ch		335 9.3 B	*134236*	345 11.7 Al	
344 8.7 Cl	283 11.5 Bl	318 11.4 Wk		347 9.3 Sp	283 10.8 Bl	345 11.1 Wm	
354 8.7 Pi	302 12.7 Bl	318 11.0 Kl		353 9.6 Sp	289 10.9 Ht	350 12.2 Cl	
SU VIR	T UMA	320 10.9 Ch		V VIR	295 11.7 Dr	354 11.8 Pi	
120012	123160	322 10.3 An		*132202*	296 11.1 Ht	S BOO	
326 13.6 B	315 12.5 Ch	324 10.7 Kl		330 10.6 Lg	302 11.3 Bl	141954	
354[12.0 Pi	318 11.0 Wk	325 10.5 Wk		335[12.6 B	R CVN	326 13.4 Pt	
T VIR	318 11.0 Kl	326 10.7 Kl		R HYA	134440	333 12.2 Ch	
120905	320 11.9 Ch	326 10.1 Pt		*132422*	318 10.5 Wk	354[12.0 Pi	
326 10.3 Pt	324 10.4 Kl	326 10.9 Fd		296 8.9 Sm	325 10.3 Wk	RS VIR	
327 10.4 Fd	325 10.0 Wk	326 10.4 B		301 9.0 Ch	325 10.7 Ch	142205	
329 10.4 Fd	326 10.0 Pt	329 10.0 GC		302 8.9 Bl	326 10.3 Pt	297 9.9 Bf	
330 11.0 Lg	326 10.2 B	329 10.7 Fd		324 9.4 Ch	346 9.5 Gb	V BOO	
332 10.3 B	326 10.0 Fd	329 10.6 Kl		S VIR	354 9.3 Pi	142539a	
333 10.2 Fd	326 10.2 Kl	333 9.7 Wd		*132706*	RX CEN	318 10.4 Ch	
336 10.5 Fd	329 11.1 GC	334 10.3 Wk		301 10.8 Ch	*134536*	324 10.5 Gb	
337 10.5 Kz	329 10.0 Fd	335 9.5 An		321 9.8 Ch	302[13.1 Bl	325 11.1 Fd	
337 10.9 Eb	329 10.4 Wd	337 10.0 Wd		326 9.3 Pt	T APS	326 11.0 Fd	
345 11.1 Fd	329 10.1 Kl	337 9.0 Al		329 9.3 Sp	*134677*	326 9.9 Pt	
346 10.9 Fd	333 9.8 Wd	344 8.9 B		331 9.6 Lg	287[12.7 Sm	326 9.0 Jo	
349 10.8 Fd	334 8.8 Wk	345 8.6 Al		335 9.3 B	292[12.7 En	327 11.2 Fd	
354 11.0 Fd	337 9.6 Wd	345 9.0 Jo		337 9.2 Al	302[13.2 Bl	328 11.2 Fd	
	344 9.0 B	347 9.3 Wd		345 9.1 Al		329 11.0 Fd	

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1928.

V Boo
142539a
333 11.1 Fd
336 11.3 Fd
345 11.3 Fd
345 10.3 Jo
345 10.6 Al
347 11.1 Fd
351 10.8 Al
354 10.8 Fd
354 10.8 Pi

R Boo
143227
296 7.5 Go
297 7.6 Go
298 7.6 Go
299 7.6 Go
318 8.2 Ch
320 8.6 Wk
326 8.9 Wk
326 8.5 Pt
327 8.4 Jo
345 9.2 Jo
345 10.1 Al
347 9.2 Wd
353 10.1 Pi

Y LUP
145254
302[13.7 Bl

S APS
145971
283 10.8 Bl
287 11.2 Sm
296 11.9 Sm
302 11.6 Bl
305 12.0 En

RT LIB
150018
346 8.5 Pt

Y LIB
150605
346 13.1 Pt

S LIB
151520
305 8.5 Ch
321 8.4 Ch
346 8.8 Pt

S CRB
151731
321 10.1 Ch
322 10.1 Wk
324 10.8 Gb
326 10.4 Fd
326 10.0 Pt
327 10.3 Fd
328 10.2 Fd
329 10.2 Fd
333 10.6 Fd
336 10.7 Fd
345 10.5 Fd

S CRB
151731
345 11.8 Wm
346 10.3 Fd
347 10.5 Fd
348 10.5 Fd
354 10.5 Fd

RS LIB
151822
299 11.4 Ht
302 10.8 Bl

R NOR
152849
295 9.3 Dr
302 9.0 Bl
324 9.1 Dr
328 9.3 Dr
333 9.0 Dr

X LIB
153020
302 10.8 Bl

S UMI
153378
325 10.0 Ch
326 8.8 Pt
326 9.7 Jo
345 10.7 Jo
350 11.0 Jo
354 10.5 Pi

U LIB
153620a
320 9.1 Bl

T NOR
153654
289 12.0 Ht
299 12.0 Ht
326[12.2 Dr

Z LIB
154020
302 12.0 Bl

R CRB
154428
296 5.6 Go
297 5.7 Go
298 5.7 Go
299 5.7 Go
302 6.2 Ch
308 6.0 Ch
320 6.1 Pt
321 5.9 Ch
323 5.8 Gb
324 5.8 Ch
325 6.1 Pt
326 6.1 Pt
326 5.8 Jo
327 6.1 Pt
328 6.1 Pt
329 6.1 Sp
329 6.1 Pt

R CRB
154428
330 6.1 Pt
333 6.2 Pt
336 6.1 Pt
336 6.0 L
336 6.0 Gt
338 6.1 Pt
339 6.0 Sp
345 6.1 Pt
345 5.9 Jo
346 6.0 Gb
346 6.2 Pt
346 5.9 Cl
347 6.1 Pt
348 6.2 Pt
349 6.1 Pt
350 5.8 Jo
350 6.1 Cl
351 6.1 Sp

X CRB
154536
326 10.4 Pt

R SER
154615
319 7.7 Ch
325 8.1 Ch
326 7.6 Pt

V CRB
154639
326 9.9 Pt

RZ SCO
155823
299 12.0 Ht
346 9.0 Pt

Z SCO
160021
299 11.5 Ht
302 11.8 Bl

R HER
160118
346 13.4 Pt

U SER
160210
346 13.3 Pt

X SCO
160221a
302 11.4 Bl

SX HER
160325
320 8.4 Pt
325 8.4 Pt
326 8.1 Pt
327 8.2 Pt
328 8.1 Pt
330 8.2 Pt
333 8.5 Pt
336 8.4 Pt
338 8.2 Pt
346 8.3 Pt

SX HER
160325
347 8.1 Pt
349 8.2 Pt

W SCO
160519
302[13.0 Bl

RU HER
160625a
346 12.8 Pt

R SCO
161122a
302 13.4 Bl

S SCO
161122b
290 11.4 Bf
297 12.6 Bf
302 13.9 Bl

W CRB
161138
322 11.3 Wk
329 10.9 Fd
329 10.3 Sp
346 9.4 Pt
353 9.2 Sp
354 9.7 Fd

V OPH
162112
346 8.0 Pt

U HER
162119
305 11.5 Ch
325 11.8 Ch
325 11.5 Wk
346 12.1 Pt

SS HER
162807
346 9.8 Pt

T OPH
162815
302 12.6 Bl
346 10.8 Pt

S OPH
162816
302[13.3 Bl

W HER
163137
346 12.1 Pt
353 11.4 Sp

R DRA
163266
302 9.7 Ch
320 8.3 Wk
324 7.8 Ch
325 8.0 Fd
326 8.1 Fd
326 8.0 Jo
327 8.0 Fd
328 8.1 Fd
329 8.0 Fd

R DRA
163266
333 7.8 Fd
333 8.0 Wd
336 7.7 Fd
337 8.0 Wd
338 7.7 Fd
345 7.8 Fd
345 7.7 Jo
346 7.8 Pt
346 7.7 Fd
347 7.7 Fd
348 7.7 Fd
349 7.7 Fd
350 8.0 Wd
350 7.6 Jo
354 7.8 Fd

S DRA
164055
353 9.3 By

RR OPH
164319
290 11.7 Bf
297 11.1 Bf
346 9.6 Pt

S HER
164715
304 9.6 Ch
346 10.8 Pt

RS SCO
164844
299 11.3 Ht
302 11.4 Bl

RR SCO
165030
299 6.5 Ht
302 6.4 Bl
324 6.0 Dr
326 6.0 Dr
331 6.0 Dr

RV HER
165631
346 14.5 Pt

RT SCO
165636
302[14.0 Bl

R OPH
170215
303 10.8 Ch
329 9.5 Fd
336 9.6 Fd
349 10.7 Fd

RW SCO
170833
302[13.0 Bl

Z OPH
171401
329 11.3 Sp
346 12.0 Pt

RS HER
171723
346 8.5 Pt

S OCT
172486
283 12.5 Bl
287 12.6 Ht
287 12.8 En
291 12.8 En
296 12.6 Ht
302 13.5 Bl

RU OPH
172809
346 13.3 Pt

RU SCO
173543
302 13.5 Bl

SV SCO
174135
302 11.3 Bl

W PAV
174162
299[12.3 Ht
302[13.0 Bl

RS OPH
174406
346 11.2 Pt

RY HER
175519
304 10.3 Ch
346 12.4 Pt

V DRA
175654
346 14.0 Pt

R PAV
180363
299[11.9 Ht
331[11.9 Dr

T HER
180531
304 10.8 Ch
329 7.9 Fd
336 8.0 Fd
345 7.5 Jo
346 7.4 Pt
346 7.7 Fd
347 7.8 Fd
348 7.6 Fd
350 7.2 Jo

W DRA
180565
346 11.0 Pt

X DRA
180666
346 11.2 Pt

NOV OPH
180911
346[12.0 Pt

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1928.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
RY OPH	Z LYR	R CYG	Z CYG	U CYG	S MIC
181103	185634	193449	195849	201647	*212030*
346 8.0 Pt	346 10.3 Pt	302 6.8 Ch	326 8.5 Ch	346 9.5 Fd	302 12.9 Bl
W LYR	R AQL	316 6.7 Ch	347 8.8 Pt	347 9.7 Fd	W CYG
181136	190108	329 7.3 Fd	S TEL	347 8.6 Pt	213244
346 9.4 Pt	304 10.9 Ch	336 6.7 Fd	*195855*	348 9.5 Fd	257 6.7 H
RV SGR	RW SGR	345 6.8 Fd	302 12.9 Bl	349 9.4 Fd	261 6.5 H
182133	*190819a*	346 7.4 Fd	S CYG	353 8.3 Sp	S CEP
302[13.6 Bl	308 9.5 Ch	347 7.5 Fd	200357	U MIC	213678
SV HER	X LYR	347 6.4 Pt	347 12.7 Pt	*202240*	347 8.6 Pt
182224	190926	348 7.8 Fd	S AQL	302[13.0 Bl	RU CYG
346 10.2 Pt	346 8.8 Pt	349 7.7 Fd	200715a	ST CYG	213753
R SCT	U DRA	T PAV	308 11.0 Ch	202954	347 8.5 Pt
184205	190967	*193972*	R TEL	347 13.1 Pt	RV CYG
303 5.9 Ch	304 9.4 Ch	282 8.7 Bl	*200747*	V VUL	213937
318 5.7 Ch	326 9.8 Ch	299 10.0 Bl	302 13.3 Bl	203226	347 6.2 Pt
320 5.4 Pt	346 10.2 Pt	299 9.5 Ht	W CAP	347 8.9 Pt	R GRU
325 5.3 Pt	W AQL	333[12.1 Dr	*200822*	R MIC	*214247*
326 5.3 Pt	*191007*	RT CYG	302[12.5 Bl	*203429*	302 10.0 Bl
328 5.5 Sp	305 9.7 Ch	194048	RS CYG	320 8.9 Bl	S GRU
329 5.6 Fd	R SGR	326 10.5 Ch	200938	V CYG	*221948*
333 5.3 Sp	*191019*	329 9.6 Fd	302 8.9 Ch	203847	287 11.7 Sm
333 5.4 Pt	308 11.7 Ch	336 9.4 Fd	303 8.9 Ch	347 12.0 Pt	R IND
336 5.5 Fd	333 10.3 Sp	345 9.0 Fd	304 8.9 Ch	RZ CYG	*222867*
336 5.5 Pt	354 8.5 Sp	346 9.5 Fd	305 9.0 Ch	204846	299 12.4 Bl
339 5.2 Sp	RY SGR	347 8.8 Pt	306 9.0 Ch	347 13.3 Pt	T TUC
345 5.2 Fd	*191033*	348 9.1 Fd	308 9.0 Ch	S IND	*223462*
346 5.5 Fd	302 6.3 Bl	349 8.9 Fd	310 9.0 Ch	*204954*	287[12.8 Sm
347 5.3 Pt	304 6.5 Ch	χ CYG	316 9.0 Ch	255[13.5 Bl	RW PEG
348 5.3 Fd	305 6.5 Bf	194632	318 9.0 Ch	302[13.5 Bl	225914
349 5.2 Fd	305 6.5 Ch	302 9.2 Ch	322 8.9 Ch	X CEP	286 9.6 Bf
352 5.2 Sp	331 6.6 Dr	305 8.6 Ch	325 8.8 Ch	210382	V CAS
354 5.2 Sp	333 6.2 Pt	310 8.6 Ch	326 8.9 Ch	324[13.2 GC	230759
NOV AQL	336 6.3 Dr	322 8.4 Ch	328 8.8 Sp	T CEP	347 9.0 Pt
184300	TY SGR	328 7.5 Sp	329 8.9 Sp	210868	S PEG
304 10.6 Ch	*191124*	347 5.6 Pt	347 8.3 Pt	257 9.2 H	231508
320 11.6 Pt	302[12.4 Bl	353 5.3 Sp	353 8.9 Sp	259 9.2 H	295 12.8 Pt
329 11.0 Sp	S SGR	354 5.1 Sp	RT SGR	261 9.2 H	V PHE
336 11.4 Pt	*191319a*	RR SGR	*201139*	274 9.8 H	*232746*
347 11.6 Pt	302 11.5 Bl	*194929*	302 8.1 Bl	304 10.0 Ch	287[12.7 Sm
RX LYR	SW SGR	302 13.2 Bl	WX CYG	322 10.3 Ch	291[12.0 En
185032	*191331*	RU SGR	201437b	327 10.3 Fd	R AQR
304[12.5 Ch	302 12.1 Bl	*195142*	302 10.8 Ch	328 10.4 Fd	*233815*
S CRA	TZ CYG	302 9.3 Bl	322 10.9 Ch	333 9.7 Fd	282 8.9 Bl
185437a	191350	NOV CYG	347 10.1 Pt	336 9.9 Fd	R TUC
302 11.9 Bl	333 10.6 Sp	195553	U CYG	345 9.6 Fd	*235265*
R CRA	346 10.0 Pt	320[12.2 Pt	201647	346 9.5 Fd	287[12.9 En
185537a	353 10.7 Sp	333[12.2 Pt	306 9.6 Ch	347 9.4 Fd	287[12.9 Sm
302 12.7 Bl	U LYR	346[12.2 Pt	329 9.9 Fd	348 9.3 Fd	291[12.9 En
T CRA	191637	349[12.2 Pt	333 8.4 Sp	349 9.5 Fd	296[13.0 Sm
185537b	346 10.0 Pt	Z CYG	336 9.6 Fd	354 9.6 Fd	
302 13.5 Bl		195849	345 9.5 Fd		
		304 8.3 Ch			

RAPIDLY VARYING IRREGULAR VARIABLES.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
005840 RX ANDROMEDAE—			074922 U GEMINORUM—		
5326.6 13.6 Pt	5328.6 12.4 Pt		5315.0 12.4 Ch	5332.8 14.0 Lg	
060547 SS AURIGAE—			5316.7 14.0 Lg	5333.6 11.2 Pt	
5286.2 14.7 Bf	5327.6 14.0 B		5318.6 14.0 Lg	5333.8 12.5 Lg	
5288.2 14.2 Bf	5328.6 12.6 Pt		5319.8 14.0 Lg	5337.8 12.5 Lg	
5291.2 14.5 Bg	5329.6 13.0 Wl		5320.5 13.7 GC	5338.7 10.1 Pt	
5294.2 11.7 Bf	5330.8 14.1 Lg		5321.2 12.3 Ch	5340.6 12.0 B	
5295.2 11.0 Bf	5332.8 14.0 Lg		5322.2 12.3 Ch	5343.8 14.0 Lg	
5297.2 10.6 Bf	5333.6 12.4 Pt		5323.7 14.0 Lg	5344.6 13.7 B	
5299.2 10.8 Ch	5335.3 13.3 L		5324.2 12.4 Ch	5345.6 14.1 GC	
5300.2 10.8 Ch	5336.6 13.3 Gt		5325.2 12.4 Ch	5346.6 13.3 Pt	
5300.2 10.7 Bf	5337.8 13.5 Lg		5326.6 14.0 Wl	5346.8 14.0 Lg	
5301.2 10.8 Ch	5338.6 12.4 Cl		5326.7 13.9 Lg	5347.6 13.8 GC	
5302.2 11.1 Ch	5340.6 13.0 B		5327.6 14.0 B	5348.6 12.3 Pt	
5304.2 10.8 Bg	5343.8 14.1 Lg		5328.6 13.3 Pt	5349.7 12.4 Pt	
5305.2 11.9 Bf	5344.6 12.6 Cl		5329.7 12.4 Pt	5350.6 13.7 Cl	
5306.1 12.3 Bg	5345.7 12.6 Pt		5330.8 14.0 Lg	5353.6 11.7 Sp	
5316.7 14.1 Lg	5346.8 14.1 Lg		202946 SZ CYGNI—		
5318.6 14.0 Lg	5347.6 12.8 Cl		5320.9 9.6 Pt	5346.7 9.4 Pt	
5319.8 14.0 Lg	5348.6 12.6 Pt		5325.9 8.9 Pt	5347.8 9.5 Pt	
5320.1 13.3 Ch	5349.7 12.6 Pt		5326.9 8.6 Pt	5349.7 9.5 Pt	
5322.2 13.3 Ch	5350.6 12.8 Cl		5333.9 9.6 Pt		
5323.7 14.0 Lg	5353.6 11.8 Sp		213843 SS CYGNI—		
5326.7 14.1 Lg			5315.6 12.1 L	5328.8 8.6 Sp	
074922 U GEMINORUM—			5320.9 11.7 Pt	5333.8 10.5 Sp	
5286.2 9.3 Bf	5291.2 11.2 Bg		5325.6 8.3 Ch	5333.9 10.6 Pt	
5287.2 9.5 Bf	5295.2 13.6 Bf		5325.9 8.6 Pt	5347.8 11.7 Pt	
5288.2 9.5 Bf	5300.2 14.1 Bf		5326.6 8.3 Ch	5349.8 11.8 Fd	
5290.4 10.4 Bf	5304.2 14.2 Bg		5326.9 8.8 Pt		

MONTHLY SUMMARY.

Observer	Initial	Vars.	Observations	Observer	Initial	Vars.	Observations
Allen	Al	21	40	Jones	Jo	20	42
Ancarani	An	10	17	Kohl	Kl	3	10
Baldwin	Bl	93	132	Kurtz	Kz	20	20
Bappu	Bf	24	58	Lacchini	L	18	26
Barry	By	28	72	Logan	Lg	52	82
Bhaskaran	Bg	7	10	Peltier	Pt	147	225
Bouton	B	65	82	Pickering	Pi	20	20
Brown	Bn	2	2	Prentice	Pn	2	2
Bush	Bu	3	4	Smith, F. W.	Sf	7	12
Chandra	Ch	90	166	Smith, W. H.	Sm	38	69
Clement	Cl	12	21	Spears	Sp	26	57
Dartayet	Dr	32	163	Swanson	Sw	3	3
Ebert	Eb	20	20	Waldo	Wl	23	23
Ensor	En	35	69	Watkins	Wk	23	43
Ford	Fd	24	153	Webb	Wd	10	24
Gaebler	Gb	5	17	Whitney	Wy	4	5
Giustino	Gt	8	19	Williams, R.	Wm	3	3
Gomi	Go	2	8	Georgetown	GC	27	56
Goodsell	Gs	4	6	Coll. Obs.	—	—	—
Hama	H	7	24	Totals	39	327	1863
Houghton	Ht	31	78				

LEON CAMPBELL, Recording Secretary.

May 9, 1928.

COMET NOTES.

For two reasons the comet notes for this month are brief. First, because Professor Van Biesbroeck is now on his way to Europe; second, the comets, after considerable activity during the past year or more, have recently become rather quiet. Just before starting, Professor Van Biesbroeck wrote, "I would gladly send you some 'cometary' material at this time but comets leave us in peace lately. COMET REINMUTH will soon drop out. On last night's (May 7) plates (taken by Mr. Chang) the magnitude is about 16.5."

An observation of COMET 1928 *a* (REINMUTH), made at the Lick Observatory by Dr. Crawford furnishes the following information:

1928 April 23, $5^h\ 0^m\ 0^s$ U.T.
$\alpha = 9^h\ 51^m\ 11^s.71$
$\delta = +21°\ 42'\ 57''.7$ } 1928.0

METEOR NOTES.

By CHARLES P. OLIVIER.

During April and early May our observers in Texas have been most active. In particular S. Bunch, J. H. Logan, and O. E. Monnig, assisted by D. C. Bubar and R. Brown, made the first serious attempt to carry out a scheme suggested by the writer which required simultaneous observations from three stations. The nights of April 21 and 23 were chosen and stations at Dallas, Decatur, and Ft. Worth occupied. Complete reports have been received here and a preliminary survey of them made. Due to the amount of valuable data contained in them, a special paper will be prepared later to give the results. Meantime a summary of the observations is here given.

		Began	Ended	Factor	Meteors	Station
D. C. Bubar	April 21	11:36	13:52	0.9	18	Decatur
O. E. Monnig	21	11:36	13:52	0.9	17	Decatur
J. H. Logan	21	12:00	16:00	0.6	43	Dallas
S. Bunch and R. Brown	21	12:00	15:25	0.7	22	Ft. Worth
J. H. Logan	23	13:00	16:42	1.0	23	Dallas*
S. Bunch	23	13:05	17:36	1.0	21	Ft. Worth
O. E. Monnig	23	13:05	17:36	1.0	23	Ft. Worth
S. Bunch, O. E. Monnig, R. Brown	May 1	15:00	16:45	0.4	7	Ft. Worth

J. H. Logan reported 4 telescopic and 5 casual meteors in April.
*Actually observing 164 minutes of this period.

To those of us familiar with attempted simultaneous observations of meteors from different stations it needs no explanation that, no matter how carefully the program is planned, results are not easy to get. As this was the first attempt by these observers to attack this problem and as meteors were not numerous, on the first night no certain coincidence was found, but on the second there are possibly eight. A third attempt on May 1 was ruined by moonlight, which permitted few meteors to be seen. With the valuable experience gained these observers plan to try the same program during the summer. They are to be congratulated on the success of their first attempts, the results of which will appear in due time.

Mr. Bunch secured a good radiant for the Eta Aquarids on May 1.91 G.M.T. at R.A. = 326°.4, Decl. = —1°.7, three meteors. Another probable radiant on the same night from two meteors, one a fireball, was at R.A. = 319°, Decl. = —17°. The positions of the Lyrid radiants can only be deduced with considerable labor as the meteors are scattered on many maps, and must first be transferred to one. They will appear with the heights.

A second letter has been received from Dr. Yamamoto of Kyoto Observatory in which he reports having found an error in his former computations of the apparent radiant of possible meteors for Skjellerup's Comet. His revised position is: June 7, R.A. = 30°.2, Decl. = +33°.3. Dr. Crommelin in England published a position that differs widely in right ascension but is nearly the same in declination. Our observers are therefore warned to watch the northern sky all night on June 7, and possibly on June 6 and 8, as a shower may possibly appear and it would be a great pity to miss it.

Due to the writer's probable absence in Europe from June 16 to about August 10 to attend the meeting of the International Astronomical Union, there will be no chance for him to answer letters or supply maps to our members during that interval. All A.M.S. mail will be held here unopened. As announced, the headquarters of the A.M.S. will, after September 1, 1928, be at the Flower Observatory, University of Pennsylvania, Upper Darby, Pa.

1928 May 21.

GENERAL NOTES.

Dr. William H. Wright, astronomer of the Lick Observatory, has been awarded the Henry Draper medal of the National Academy of Sciences. (*Science,* April 27, 1928.)

Mr. C. T. Elvey has been appointed instructor in the University of Chicago for the academic year of 1928-29, with duty at the Yerkes Observatory in the work of stellar spectrography.

Dr. Frank Schlesinger, director of the Yale Observatory, lectured before the Amateur Astronomers Association at the American Museum of Natural History on April 19. (*Science,* April 27, 1928.)

Professor Harlan T. Stetson, of the Harvard Astronomical Laboratory, has been appointed Exchange Professor from Harvard University to Carleton, Grinnell, and Pomona Colleges for the second half year 1928-29.

Dr. Robert A. Millikan, of the California Institute of Technology, will be the principal speaker at the dedication exercises on April 28 of the new science hall at Berea College and Allied Schools. (*Science,* April 27, 1928.)

Professor G. W. Ritchey delivered an address on May 11 before the Royal Astronomical Society, in which he explained the method of the construction of "cellular" mirrors carried on at the Paris Observatory. On May 16, Professor Ritchey spoke on "The Modern Reflecting Telescope," before the Optical Society in the Imperial College, South Kensington.

Edison to Receive Medal.—Thomas Edison will receive the gold medal for science of the Society of Arts and Sciences, New York, on May 24, it has been announced. Walter Russel, president of the society, will preside at a banquet at the Hotel Astor, at which the medal will be bestowed, while Dr. Edwin E. Slosson, director of *Science Service*, will be toastmaster. (*Science News Letter*, May 19, 1928.)

Professor George Van Biesbroeck and his wife, with their six year old son, Edwin, left Yerkes Observatory on May 10, for a motor trip to Leiden, Heidelberg, Innsbruck, Bruxelles, and intermediate points. Their Buick, equipped with all conveniences for camping on the Drachenfels, or on the Furka, will rest between Montreal and Liverpool, and again between Harwich and the Hook. Their first day's run from Williams Bay to Ann Arbor having been easily accomplished we venture to believe that the speed of the *Minnedosa* will seem slow to them. They expect to return to the United States at the end of August.

Professor Georg Struve, of the University of Berlin's Research Observatory at Neubabelsberg, has been sent by the Prussian Government on a visit to the Yerkes Observatory as a guest and as an honorary Research Associate of the University of Chicago. He will arrive at the Observatory in the first week of June and will undertake the observation of double stars and faint satellites with the 40-inch telescope during the summer. He is the only son of the late Hermann Struve, director of the observatory at Babelsberg and is therefore a cousin of Professor Otto Struve of the staff of the Yerkes Observatory. The last named of this family of astronomers has received a fellowship from the Guggenheim Foundation and expects to leave the Yerkes Observatory on August 1 for an absence of ten months. He will spend his time chiefly in study with Professor Eddington at Cambridge. He will be accompanied by Mrs. Struve.

Fellows of the Royal Astronomical Society.—Among those elected as Fellows of the Royal Astronomical Society at its meeting on April 13 are Miss Ida Barney, of the Yale University Observatory and Mr. David B. Pickering, East Orange, New Jersey, president of the A.A.V.S.O.

American Association of Variable Star Observers Meeting.—The spring meeting of the A.A.V.S.O. is to be held at Vassar College on Saturday, June 2, 1928. A full program of business and social sessions has been planned for the day concluding with the Association Dinner at the Alumnae House at 6:30.

American Astronomical Society.—The announcement of the fortieth meeting of the American Astronomical Society has been sent out by the Secretary. The meeting will be held at Amherst College, September 10 to 13, 1928. The usual sessions for papers, teas, and special dinner have been provided for during these four days.

New Members of the National Academy of Sciences.—According to *Science* for May 4, 1928, the following persons were elected to membership in the National Academy of Sciences at the recent meeting in Washington:

Dr. John August Anderson, astronomer at the Mt. Wilson Observatory; Dr. William Mansfield Clark, professor of biochemistry at the Johns Hopkins Medical

School; Dr. Arthur Keith, of the U. S. Geological Survey; Charles F. Kettering, head of the research laboratory of the General Motors Corporation; Dr. Alfred L. Kroeber, professor of anthropology at the University of California; Dr. Rudolph Ruedemann, state paleontologist for New York; Dr. Philip A. Shaffer, professor of biochemistry at the Washington University Medical School; Dr. George M. Stratton, professor of psychology at the University of California; and Dr. Lewis M. Terman, professor of psychology at Stanford University.

Observatorio del Ebro.—A volume of 180 pages by P. Ignacio Puig, giving a detailed account of the equipment, organization, and work during the twenty-three years of its existence, of the Ebro Observatory, has just been received. The work contains numerous diagrams and photographs of the instruments and buildings which add much to the interest and understanding of the reader. Work is carried on at the observatory in seismology and meteorology as well as in solar physics. From the description given in the volume, one is led to ascribe to this observatory a very attractive setting and a large amount of important and valuable work.

Harvard College Observatory.—The eighty-second annual report of the Director of The Astronomical Observatory of Harvard College, for the year ending September 30, 1927, to the President of the University consists of thirteen pages closely packed with information concerning the research carried on at this institution. Sixty-one items are mentioned as constituting the program of work at the Observatory during the period. "The outstanding events," in the words of the director, Professor Shapley, "are the transfer of the Boyden Station to South Africa and the provision of a large reflector for the southern hemisphere."

The reading of this report will serve to give one a good idea of the extensive work which is being done in the astronomical sciences at present.

Green Ray Seen from Ship.—Intending voyagers to Europe during the next few months should carefully watch the setting sun, and they may be able to see the "green ray." This is the brilliant green coloration that the sun assumes just before its last narrow sliver disappears behind the horizon. A really satisfactory sight of it is rather rare, said Professor R. W. Wood, professor of experimental physics at Johns Hopkins University. On thirty crossings of the Atlantic he has looked for it every time there was a clear sky, and no haze or clouds near the horizon at sunset, but has only seen it three or four times. Only once, he said, was it really striking. At that time it appeared a brilliant emerald green, about the color of a railroad signal.

The cause of the green ray is generally supposed to be that the rays of light are bent as if by a prism when they pass through the atmosphere of the earth. This enables us to see the sun for a short time after it is below the line of the horizon. As the red and orange rays are bent least, they disappear first behind the horizon. This leaves the green, blue, and violet rays still visible. Blue and violet affect the eye much less strongly than green, and so the green color predominates.

Dr. Wood accepts this theory of the origin of the ray, but proposes a new theory to explain why it is not always seen at sunset. At the time that he saw the ray so well, the air and ocean were at approximately the same temperature. Through the rest of the voyage, when it was not seen, the ocean was much warmer than the air. He thinks that when the water is warm and the air cool.

the layer of warm air right in contact with the sea would cause the light rays of all colors to be bent less, and so the sun would set abnormally early. When the air is warmer than the water, the curvature of all the rays would be increased, and so the atmospheric dispersion that causes the ray would have a longer time to act.

Anyone seeing the ray from the ocean is requested to send an account of his observation, and the ocean and air temperature at the time, to Professor Wood in Baltimore. (*Science News Letter*, May 12, 1928.)

Chabot Observatory Activities. — On the first Saturday evening of each month the East Bay Amateur Astronomical Association meets at the Observatory. The meetings are open to the public and tax the capacity of the public lecture hall. Lecturers from the University of California Department of Astronomy and from other observatories bring us the best they have upon special topics. Occasionally international visitors come to dine here with the members of this organization. Mary Proctor, famous English astronomer, was our guest in April. A column is maintained in the news section of *The Oakland Tribune* each Sunday where a little picture of the Observatory will guide your eye from the more sordid news of the day to things of interest in the program of the Observatory.

KTAB, dedicated to community interests, has through the coöperation of the Richfield Oil Company placed a microphone on the desk of the Director of the Observatory in his Mills College office, and thus the radio listeners also are in touch with the activities of the Observatory. This opportunity is enjoyed by thousands. (*Taken from Mills College Radio Programs circular.*)

Zodiacal Light Observations.

Reports of observations have been received as follows: Professor Leah B. Allen, Williams Observatory, Hood College, Frederick, Md., on February 12, 14, 19, 21; March 8, 14, 20, 21, 22; April 12 and 15. Miss Rebecca Jones, Lick Observatory, all through February with special detailed report for February 13. Mr. Oscar E. Monnig, Ft. Worth, Texas, January 14; February 8, 22; March 10, 13, 17. Miss Eleanor Musser, Hood College, February 14 and 19. The writer has records of observations on January 11, 14, 23; February 12, 19, 20, 21; March 8, 23; April 6, 8, 10, 19; May 7.

NOTES.

1. Observers are in general agreement that the main axis of the Light shows slightly north of the ecliptic, from 2 to 3 degrees. During January the south side of the Great Square of Pegasus was clear of the Light. As the equinox approached, the south side was covered by the Light. Towards the end of February, Aries, which had earlier been clear of the Light, began to be involved and was increasingly so during March. During January and the first half of February Jupiter was slightly north of the main axis but later, until it disappeared from the evening sky, it was increasingly nearer the south boundary of the Light. On March 23 the moon, two days old, was seen almost on the south boundary while the north boundary enveloped Aries.

2. As to brightness, the agreement is unanimous. For January Mr. Monnig reports that "the brightest part of the Zodiacal Light appeared of about the same brilliancy as the brighter portion of the Milky Way in Cygnus." For February Miss Jones reports that "its brilliance almost makes the Milky Way seem quite pale."

3. Extensions of the Zodiacal Light band beyond the apex have received at-

tention. In her report for April 12, Professor Allen says that she thought probably there was a faint extension as far as Cancer, and on April 15 she noticed that Cancer and the western part of Leo along the ecliptic were brighter than the eastern part of Leo.

4. Concerning the Zodiacal Light in the evening eastern sky, Miss Jones writes that "several times on an especially clear night there has been a faint glow of light in the east where the band would be if it extended clear across the sky." On May 7 the writer noticed an illumination along the eastern horizon of the Zodiacal zone at 8:45. It extended from the horizon to Libra. Moonrise on that evening was at 10:00 o'clock. Possibly this was the phenomenon described by Houzeau and Chaplain Jones as a moon zodiacal light.

Special mention should be made of the two very creditable charts prepared by Miss Eleanor Musser, a beginner in astronomy at Hood College.

List of References—II.

Abbe, C., *Bull. Mt. Weather Obsy.*, 1914, **6**, pt. 3.
Birkeland, K., *Comptes Rendus*, 1911, pp. 345-348.
Below, E. E. A., *Sirius*, 1921, **54**, pp. 75-78.
Claridge, J. T. W., *Knowledge*, **37**, pp. 204-206.
Hall, M., *Himmel u. Erde*, 1891, **3**, pp. 270-272.
Houzeau, J. C., *Astron. Nach.*, 1844 (58 observations).
Jacob, W. S., *Mem. R.A.S.*, **28**, pp. 119-121.
Lewis, H. C., *Amer. Jour. Sci.*, 1880., **20**, pp. 437-445.
Marchand, E., *Meteorol. Ztschr.*, 1896, p. 233; *Les Sciences Populaires*, 1896, **10**, pp. 14-15.
Perrotin, H. J. A., *Comptes Rendus*, 1900, **130**, pp. 1684-1685.
Reichenbach: *Poggendorf's Annalen*, 1858, Dec.
Schmidt, J. F. J., *Astron. Nach.*, **73**, p. 199.
Seeliger, H., *Sitzber. München. A.K.*, **31**, pp. 265-291.
Sherman, O. T., *Him. u. Erde*, 1889, **1**, pp. 577-583.
Thomson, Elihu, *Science*, 1927, Oct. 21, pp. 376-377. (Very interesting.)
Tupman, G. L., *Monthly Notices*, **32**, pp. 74-77.
Wilkes, C., *Proc. A.A.A.S.*, 11th Mtg., 1858, pp. 83-92.

W. E. Glanville.

The Rectory, New Market, Maryland, 1928 May 9.

Student Notes from the Vassar Observatory.

Contributed by Miss Caroline E. Furness.

Jupiter's Second Satellite. This satellite is so near the planet that it is seldom possible to observe it between the reappearance from occultation and the disappearance into eclipse. Such occurrences frequently take place but not at times convenient for observation and I have never chanced to see one. They are not particularly valuable astronomically but are interesting phenomena to observe. Accordingly last winter I selected one for our students to watch and this is their result.

"December 6, 1927. Five-inch telescope, power 120. Satellite II appeared at $8^h\,43^m\,22^s$, Eastern Standard Time, as a very tiny bright spot on the right edge of Jupiter. It grew a little brighter as the distance between it and the planet lengthened. Then at $8^h\,48^m\,6^s$ it disappeared. I used two stop watches to record the times and compared them with the chronometer." Irma Courtice.

The error of the chronometer was known and applied. The roof of the shelter of the 5-inch was entirely open and the air was steady.

"Twelve-inch telescope in dome. Air not so steady as outside. Chronograph used. Reappearance from occultation $8^h\,42^m\,34^s.5$. Disappearance into eclipse

$8^h\ 48^m\ 35^s$. Satellite was a fine point and grew decidedly fainter before disappearance. Visible longer than four minutes (the time predicted in the *Almanac*)." C. E. FURNESS.

COMPARISON WITH TIMES PREDICTED IN THE *Almanac*.

Gr. Civ. Time	*Alm.*	5-inch	12-inch
Re Occ	$7^d\ 1^h\ 43^m$	$1^h\ 43^m\ 22^s$	$1^h\ 42^m\ 34^s.5$
Dis Ec	1 47.2	48 6.2	48 35

Solar Halo. A very fine solar halo was visible in Poughkeepsie, N. Y., on Tuesday, May 8, following a sudden drop in the temperature the night before. The sky in the morning was a dull blue which displayed the halo to fine advantage, but in the afternoon white clouds began to fill in which later completely obscured it. The observations are as follows: 12:00 noon, a faint suspicion of the ring; 12:30, the ring was complete but not yet sharply defined; 1:00, the inner edge was very distinct but no coloring was visible; 2:30, there was decided coloring, red on the inside fading to whitish blue on the outside. The colors were more distinct on the upper half of the circle; 4:00, the ring had begun to disappear due to the presence of floating white clouds in front of it. These gradually filled in and by 4:30 the ring was almost entirely obscured, only the upper portion being faintly visible.

The radius of the inner edge of the ring was measured with the cross-staff by ten members of the department about 2:30, and the mean found to be 23°.7, a value somewhat larger than that given by Milham which is 22° though he does not state explicitly which part of the ring was selected as the circumference. The width was about five degrees.

Many Poughkeepsie people noticed the ring between 2:30 and 3:00 and telephoned out to the Observatory for an explanation of it.

On Wednesday, May 16, about 11:30 A.M., a similar halo was noticed, but as the sky was full of whitish clouds it was not distinct and its course was not followed. At 2:30 P.M. it was still faintly visible through the clouds, but half an hour later, though the clouds had cleared away, the halo had disappeared. Meantime the temperature had risen decidedly.

Double Stars Measured by Interference Method.—In my reading of POPULAR ASTRONOMY, to which the College is a subscriber, I have noticed some space devoted to contributions from amateur astronomers. Accordingly, I thought it not amiss to submit a brief account of a series of double star measurements made recently by a fellow student and myself, and which are, we feel, a practical demonstration of what may be done in the field of precision with a small telescope.

The results, which we find are quite consistent with the latest measurements made by Mr. Van Biesbroeck and others, are given in the accompanying table.

They were obtained by the interference method; the interference pattern being produced by a multiple slit grating in front of the object lens of a 3-inch refractor. According to the principles of slit interference, the grating converts the light from a star into a series of images in the focal plane, whose angular separation is λ/d; λ being the effective wave-length of the star light, and d the slit separation in the grating. In the case of a double star, the slits are adjusted perpendicularly to the position angle of the pair; when the images of each star will lie in the same straight line. Now by rotating the grating in the plane per-

DOUBLE STAR MEASURES BY BROWN AND HOXIE. YEAR, 1928.2.

Star	Position Angle	Separation	
β Cygni	...	34".9	
α Geminorum	...	4.34	two separate
α Geminorum	212°	4.36	sets of readings
ζ Ursae Majoris	144	14.76	
γ Leonis	116	3.96	
54 Leonis	...	5.83	
ζ Orionis	...	2.95	
γ Arietis	0	8.4	
γ Andromedae	64+	10.00	
ξ Ursae Majoris	85	2.12	
γ Virginis	317	5.68	
π Bootis	104.5	5.69	
δ Serpentis	183	3.59	
α Herculis	107	4.13	
70 Ophiuchi	125	6.22	

pendicular to the slits, the effective slit width d is adjusted so that the images of one star exactly bisect the distance between the images of the other star. In this condition, the angular separation of the double star is given by $\rho = \lambda/2d$. The product of this into 206,265 gives the angle in seconds of arc. The effective value of d is measured by the cosine of the angle made by the grating with the normal to the optic axis.

The effective wave-length of the different stars is determined according to their spectral type, by methods described by J. A. Anderson and others in the reports of the Mount Wilson Observatory, and in the *Astrophysical Journal*. Further corrections for wave-length are also made according to the zenith distance; this, however, is not always appreciable.

The chief beauty of the apparatus is its extreme simplicity. We constructed it according to a description found in the *Journal of the British Astronomical Association* (February, 1925). It consists merely of a projecting support, holding in front of the telescope lens an open frame, grooved to receive the grating. The whole support is rotated into the position angle of the double star. This angle is read on a divided circle around the telescope tube. The inclination of the grating, as described above, is accomplished by means of cords attached to each side of the frame, and reaching to the eye end of the telescope.

Of course, this method is by no means original with us, yet we do not believe it to have received the serious attention, among amateur observers, of which it is worthy, opening as it does the field of precise double star work to the user of a small telescope.

ALBERT F. BROWN, HAROLD J. HOXIE.
Washington Missionary College, Takoma Park, Washington, D. C. April 21, 1928.

BOOK REVIEWS.

Second Collection of Astronomical Sketches, by Elis and Bengt Strömgren. (Julius Springer, Berlin; Price $1.65.)

This is the translated title of a book of about one hundred fifty pages publihsed in German a few months ago. The authors have endeavored to present a few of the problems in astronomy which appeal to the general reader in such a way that the general reader can comprehend them. There are eleven sketches in

this collection ranging from "The Wonder in Jena," (meaning the Zeiss Planetarium). "The Two Body Problem," "Observations without Observer," and so forth, to the final one, "Recollections of a Journey to America," with remarks concerning astronomy in America. Anyone who can bring to this volume a sufficient knowledge of German and an intelligent interest in astronomy will find it interesting, instructive, and entertaining.

The Constellations and their History, by Charles Whyte. (Charles Griffin and Co., London; J. B. Lippincott Co., Philadelphia.)

This book treats the constellations chiefly in their historical and legendary aspects. The author, however, touches upon other phases of astronomy and astrophysics, such as the nature of stars, their distances, and their spectra. There are maps of the sky for each month of the year. Each constellation is considered and the interesting objects in it noted. It consists of nearly three hundred pages, and contains much interesting and useful material. It will be found valuable both for general reading and for reference.

A Guide to the Constellations, by Samuel G. Barton and Wm. H. Barton. (McGraw Hill Book Co., New York. $2.50.)

This work deserves a high place among the rather numerous publications along the same line. It is the second book in the McGraw-Hill Astronomical Series, under the editorship of Dr. Edward A. Fath. It is at once evident that great care was given both to the preparation of the text and to the mechanical work. It is printed on heavy paper and consequently the charts and diagrams are well presented. One can confidently turn to this work for information on the questions which arise as soon as one begins to consider astronomical problems. A suggestive bibliography and an extensive index add to the usefulness of the volume. It can be heartily recommended to any who may be desirous of learning the stars and thus avoiding the disappointment of Thomas Carlyle, as expressed in a quotation in the beginning of this book: "Why did not some one teach me the constellations and make me at home in the starry heavens, which are always overhead, and which I don't half know to this day."

Lehrbuch der Physik, Mueller—Pouillet; Funfter Band—Zweite Hälfte, Physik des Kosmos, herausgegeben von August Kopff. (Friedr. Vieweg & Sohn, Braunschweig, 600 pp. Price 39.50 marks, bound.)

This volume is one part of the 11th edition of a well-known work on physics and deals with cosmical physics from the standpoint of the physicist rather than from that of the astronomer. In consequence the first two chapters give only brief statements concerning the fundamental concepts of astronomy and physics and concerning astronomical instruments and methods. The real development begins with the third chapter on "A star as a luminous gaseous sphere." Then follow chapters on the sun, other bodies of the solar system, the stars, double and variable stars, star clusters and nebulae, the stellar system, the problems of cosmogony and the theory of relativity. The authors of the various chapters are P. ten Bruggencate, H. Kienle, J. Hopmann, R. Emden, K. Graff, C. Wirtz, J. Hellerich, E. von der Pahlen, and A. Kopff.

A book of this character is of great value to the astronomer in that it gives him a somewhat different point of view from which to scan his own field. The

material is well chosen and ably presented. The reviewer especially liked the chapter on cosmogony. While the book is written primarily from the technical physical standpoint, it nevertheless can be recommended as worth the reading by anyone who has only a modest equipment in the way of astronomical and physical training.

The text and the line drawings are well printed. Most of the half-tones are also good. Printer's errors are few. There are 139 figures in the text and 14 plates. The book can be welcomed as of real value to those who read the language and who are interested in the modern physical concepts of the universe. E.A.F.

An Experiment with Time, by J. W. Dunne. (The MacMillan Company, 1927.)

The theory of n-dimensional time set forth by J. W. Dunne in "An Experiment with Time," was developed in an effort to explain why in dreams future events may be visioned with considerable accuracy.

In a search for the explanation, the author turned to an examination of the structure of time. The usual consideration of time as a fourth dimension was not sufficient to explain what seemed to be a "displacement in time itself." In one's waking moments he is so occupied with the circumstances of ordinary time that "time" of higher dimension does not secure recognition. When sleeping one has freedom in time and both the future and the past are accessible to him.

The same abstraction from the present may be cultivated when one is awake. The easy road of associated images leads only to images of the past but by determinedly ignoring these images the author claims that the observer may train his attention to rise to the field of true time where it is possible to move forward and see the associated images of the future.

By similar reasoning the argument may be extended to fields of any dimension in time, each of which contains the lower dimensional fields.

The argument is ingenious and is illustrated by many diagrams which are of material assistance to the reader. M. B. W.

Handbuch der Astrophysik.—Edited by G. Eberhard, A. Kohlschütter and H. Ludendorff, 8 vo. (Julius Springer, Berlin. Price 68.70 marks, bound.)

The great development in astrophysics in the last few years has led many a one to express the wish that the great amount of material published might be brought together in a readily accessible form by those who have had a part in the gathering and sifting of the data and the setting up of working theories. This promises to be accomplished in the publication of the work named above. It is expected that the six volumes will be out by the end of 1929. Volumes I, II, and III will deal with the foundations of astrophysics, as to theory and instruments, volume IV will deal with the solar system and volumes V and VI with the stellar system and nebulae.

The authors, who number about thirty, are each responsible for one or more chapters covering the field in which they are active. They are located in Austria, Canada, England, Germany, Holland, Italy, Norway, Sweden, and the United States. The languages used are English and German. The contributors from the United States are H. D. Curtis, R. H. Curtiss, S. A. Mitchell, and H. Shapley.

Volume VI is the first to appear. A brief description of this volume will give a good idea of the great project. Dr. Malmquist of Lund devotes 47 pages to a

chapter on the Radial Velocities of the Stars under the headings: Introduction, Lists and Catalogs, The Solar Motion derived from Radial Velocities, The distribution of Stellar Velocities as derived from the Radial Motions, and the Radial Velocities combined with other Attributes of the Stars. Professor Ludendorff of Potsdam follows with a chapter of 200 pages on Variable Stars; Professor Stratton of Cambridge contributes a chapter of 45 pages on Novae, and Dr. Henroteau of Ottawa closes the volume with a chapter of 170 pages on double and multiple stars. As an indication of the fullness of treatment of individual subjects we note that Professor Ludendorff devotes 8 pages to the theories of Cepheid variables; Professor Stratton uses nearly 20 pages in discussing the spectroscopic history of novae, and Dr. Henroteau uses 16 pages in describing methods of calculating the orbits of spectroscopic binary stars.

Extensive bibliographies, many references to original publications and tables of data make this volume of the greatest value in the study of the subjects dealt with.

The printing is well done on a good quality of paper and the illustrations in general are ample.

If the remaining volumes are as good as this one the editors and authors will deserve the warmest thanks of the astronomically minded for the production of this great work. E.A.F.

Zur Charakterisierung der spektroskopischen Doppelsterne, by Arthur Beer. (Veröffentlichungen der Universitäts-Sternwarte zu Berlin-Babelsberg, Band 5, Heft 6. Berlin, 1927, pp. 131.)

The publication by Dr. Arthur Beer represents a careful statistical study of spectroscopic binaries. The author has collected his material from all available sources, and his various tables, supplied with references to individual publications, will be of value to all practical workers.

The first part, on "Variable Radial Velocities," deals chiefly with the relation between period and amplitude. Certain groups of objects, such as Cepheids, or stars of the β Canis Majoris type do not follow the Keplerian equation

$$K = C \cdot P^{-1/3}$$

and cannot be regarded as true binaries. Most of the other stars obey the equation statistically, but definite variations in the numerical value of the constant C are found, if the material is subdivided according to certain characteristics. Beer finds, for example, that binaries with both components of the spectrum visible have a value of C much in excess over stars showing only one spectral component. This would indicate that spectroscopic binaries, in general, even after the exclusion of Cepheid variables and of the stars of the β Canis Majoris type, constitute a mixture of objects of different masses and mass-ratios. This is doubtless partly due to differences in spectral type and partly to the fact that the material is not quite representative. It is obvious, for example, that with the small dispersions of our present-day spectrographs, double-lined stars will be observable only if the mass is large, since otherwise the separation of the two components may be too small for the resolving power of the instrument. Dr. Beer has succeeded in showing that the material is not homogeneous.

The general tendency of all stars not belonging to one of the two groups mentioned above to agree with Kepler's third law is very strikingly demonstrated in a number of diagrams. By introducing a new unknown, $\xi = P^{-1/3}$, Beer simplifies the equations, and obtains a number of straight lines for his different

groups. There can be little doubt that most of the stars represented on these diagrams are actually double, and there is no need for any other explanation of the variable radial velocities except in the case of Cepheids and β Canis Majoris stars.

The second part of the book discusses the apparent distribution of spectroscopic binaries on the celestial sphere, while the third part is devoted to a statistical examination of the various orbital elements, and deals chiefly with the masses.

A detailed study of this sort not only reveals interesting statistical relationships, but it also shows us where our material is deficient. Outstanding cases may be due to unusual physical or mechanical properties of the stars concerned, or they may only appear so because of errors in the published observations or orbits. It should not be forgotten that in many cases the measures are at the very limit of what our instruments are capable of giving. Dr. Beer's study enables the reader to pick out individual stars which are in need of further observational work.

O. STRUVE.

International Astronomical Union.— The editor of POPULAR ASTRONOMY is planning to be in attendance at the meeting of the I.A.U. in Leiden in July and also at the meetings of the Astronomische Gesselschaft in Heidelberg which will be held just following the Leiden meetings. The readers may look forward to an account of both of these sessions in the October issue.

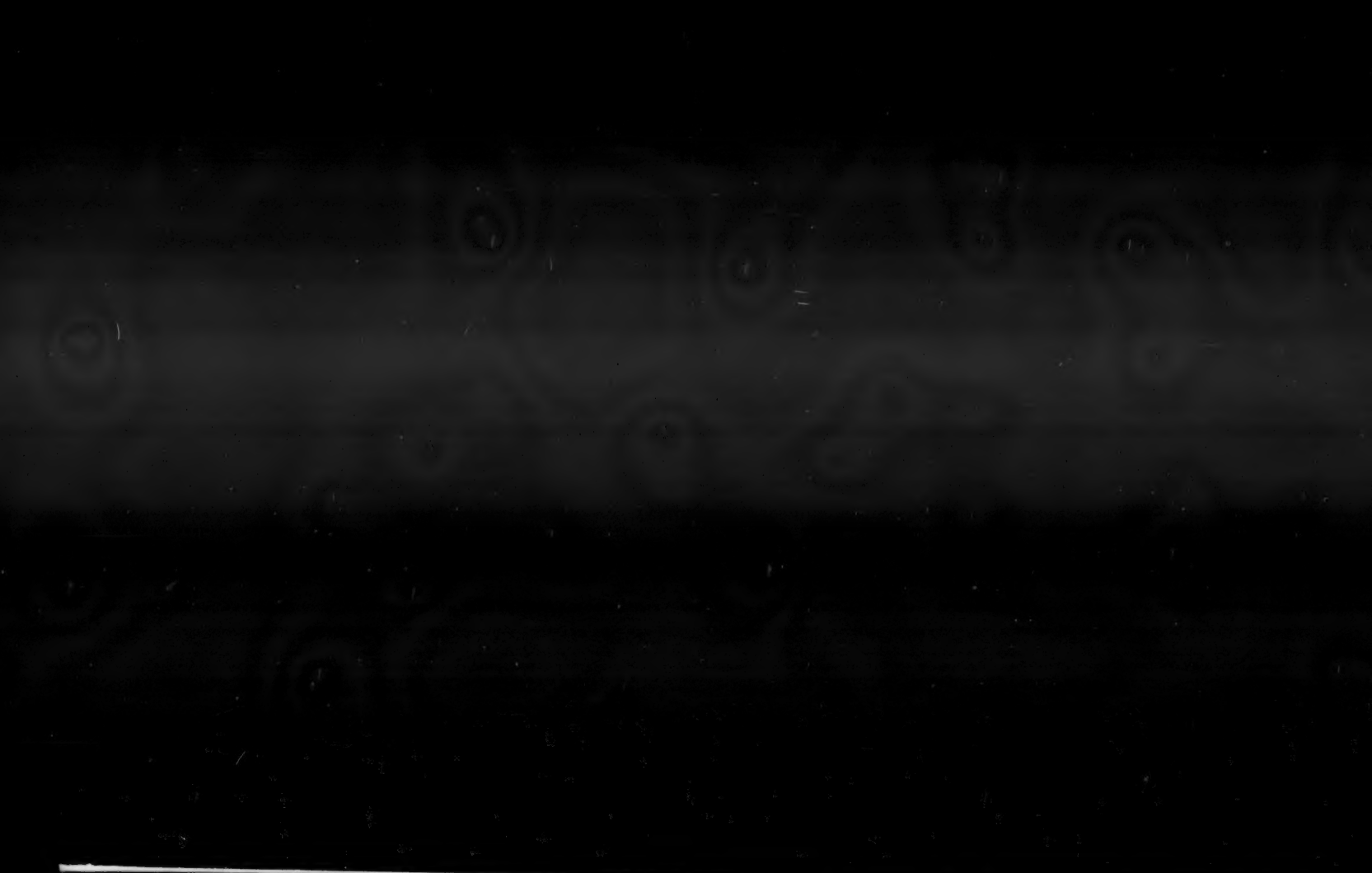
PUBLISHER'S NOTICES

SUBSCRIPTION PRICE.—The price of Popular Astronomy to subscribers living in the United States, or in a country to which the special rate of postage is applicable, is $4.00 per volume, of ten numbers; in Canada, $4.25; to all others, $4.50; in each case payable strictly in advance. Checks or Postal Money Orders should be made payable to Popular Astronomy.

RENEWALS.—Notices of expiration of subscription are sent directly after the last number of this publication for which payment has been made. It is especially requested that subscribers send renewal, or order for renewal, promptly as this publication will not be continued beyond the time for which it has been ordered.

CONTRIBUTORS are asked to prepare copy carefully, and write all proper names very plainly. If other language than the English is used to any considerable extent it should be type-written. Manuscript to be returned should be accompanied by postage for that purpose.

REPRINTS of articles, when desired, will be furnished to authors at the actual cost involved. Those wanting reprints should order them when the manuscript is sent to the editor. They cannot be furnished later without incurring much greater expense.

POPULAR ASTRONOMY,
Northfield, Minn., U. S. A.

CURVIN H. GINGRICH, *Editor* EDWARD A. FATH, *Associate Editor*